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Evidence Gap and Intervention Heat Maps of Climate Change Adaptation in Low- and Middle-Income Countries

Doswald, Nathalie; Sánchez Torrente, Luis; Reumann, Andreas; Leppert, Gerald; Moull, Kevin; Rocío Pérez, Jerónimo José; Köngeter, Alexandra; Fernández de Velasco, Guido; Harten, Sven; Puri, Jyotsna

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DEval Discussion Paper

EVIDENCE GAP AND INTERVENTION HEAT MAPS OF CLIMATE CHANGE ADAPTATION IN LOW- AND MIDDLE-INCOME COUNTRIES

2020

Nathalie Doswald
Luis Sánchez Torrente
Andreas Reumann
Gerald Leppert
Kevin Moull
Jerónimo José Rocio Pérez
Alexandra Köngeter
Guido Fernández de Velasco
Sven Harten
Jyotsna Puri

GREEN CLIMATE FUND | Independent Evaluation Unit

AAE Asesoramiento Ambiental Estratégico

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German Institute for Development
Evaluation (DEval)
Fritz-Schäffer-Straße 26
53113 Bonn, Germany

Phone: +49 (0)228 33 69 07-0
E-Mail: *info@DEval.org*
www.DEval.org

Green Climate Fund Independent Evaluation Unit
175, Art center-daero
Yeonsu-gu, Incheon 22004
Republic of Korea

Phone: (+82) 032-458-6450
E-Mail: *ieu@gcfund.org*
https://ieu.greenclimate.fund

Asesoramiento Ambiental Estratégico (AAE)
Plaza Independencia 808, Apt. 1001
11100 Montevideo, Uruguay

Phone: (+598) 2900 34 55
E-Mail: *aae@aae.com.uy*
https://aae.com.uy

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Authors

Nathalie Doswald
Luis Sánchez Torrente
Andreas Reumann
Gerald Leppert
Kevin Moull
Jerónimo José Rocío Pérez
Alexandra Köngeter
Guido Fernández de Velasco
Sven Harten
Jyotsna Puri

Editing

Deborah Hong, Greg Clough

The German Institute for Development Evaluation (DEval) is mandated by the German Federal Ministry for Economic Cooperation and Development (BMZ) to independently analyse and assess German development interventions.

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The Independent Evaluation Unit (IEU) was established by the GCF Board as an independent unit, to provide objective assessments of the results of the Fund, including its funded activities, its effectiveness, and its efficiency. The IEU fulfils this mandate through four main activities:

- Evaluation: Undertakes independent evaluations at different levels to inform GCF's strategic result areas and ensure its accountability.
- Learning and communication: Ensures high-quality evidence and recommendations from independent evaluations are synthesized and incorporated into GCF's functioning and processes.
- Advisory and capacity support: Advises the GCF Board and its stakeholders of lessons learned from evaluations and high-quality evaluative evidence and provides guidance and capacity support to implementing entities of the GCF and their evaluation offices.
- Engagement: Engages with independent evaluation offices of accredited entities and other GCF stakeholders.

About this DEval Discussion Paper

This paper presents evidence gap and intervention heat maps for climate change adaptation interventions in low- and middle-income countries. The evidence gap map describes where high-quality evidence exists and highlights gaps in available evidence. The intervention heat map overlays the project/investment portfolio with the areas of evidence. It indicates whether the portfolio operates in evidence-rich or evidence-scarce fields.

Foreword

Targeted information, based on evidence, is crucial for decisions on adaptation related matters. However, because climate change adaptation is still a fairly new policy field, accessing such evidence can be cumbersome and challenging. While publications in the field of adaptation have risen exponentially in recent years, evidence is often scattered across many different sources, such as impact evaluations and systematic reviews contained in different journals, databases and grey literature. Enhancing access to evidence in a particular sector and/or across sectors can greatly contribute to policymaking, research, and evaluations. In this context, evidence gap maps can prove to be a great addition to the tools available to support informed policymaking by enabling practitioners to explore the findings and quality of existing evidence.

The evidence gap map of climate change adaptation in Low- and Middle-Income Countries presents a variety of adaptation approaches taken in some of the most vulnerable countries around the world, from the perspectives of intervention and outcome groups. It provides a comprehensive overview of the state of evidence in the area of climate adaptation. Being framed around key adaptation sectors, such as water, forestry, fishery and agriculture, land-use and built environment, as well as social, economic and public health considerations, it highlights what kind of evidence for adaptation in these sectors exists as well as where evidence gaps are found. In addition to the evidence gap map, the Independent Evaluation Unit (IEU) of the Green Climate Fund (GCF) and the German Institute for Development Evaluation (DEval) were able to overlay the evidence gap map with an intervention heat map that depicts individual investment flows to the same intervention and outcome areas for the purposes of highlighting potential gaps of climate finance flows as well.

This evidence gap map together with the intervention heat map provides a unique opportunity to address adaptation processes across a variety of sectors. This tool can effectively serve the needs of policymakers by providing them with a collection of solid evidence for climate action of tomorrow.

I am confident that this evidence gap map will be useful to a wide range of stakeholders including adaptation practitioners, policymakers and evaluators. Thank you very much.

Dr Youssef Nassef
Director, Adaptation Division
Acting Director, Intergovernmental Support and Collective Progress Division
United Nations Framework Convention on Climate Change

DEval-IEU Joint Foreword

Climate change is one of the greatest challenges of our time and requires international cooperation to adapt to its impacts.

Since August 2018, the Independent Evaluation Unit of the Green Climate Fund (GCF) and the German Institute for Development Evaluation (DEval) have been developing a strategic learning partnership to exchange technical expertise and knowledge on the evaluation of climate change adaptation. The mutual cooperation has been invaluable in tackling the complexity and difficulties of evaluating climate change adaptation. The partnership has been making our evaluation activities more effective and beneficial to generating new evidence and ultimately to fulfilling our institutional mandates.

This report includes a jointly produced evidence gap map that facilitates evidence-based policymaking by ensuring that the best evidence is available to inform policymakers and the implementation of climate change adaptation. It shows where more evidence needs to be generated and where activities are already backed by evidence. To complement the evidence gap map, the IEU-Deval cooperation has also pioneered an innovative tool to indicate how evidence-based the project/fund portfolios of international development actors are. This intervention heat map provides a systematic overlay of the global evidence base with the climate change adaptation portfolios of the GCF and the bilateral German development cooperation. It shows whether the portfolio matches the evidence available in various sectors and intervention types.

The evidence gap map and intervention heat map combined are ideally indispensable tools for policymakers to explore the findings and quality of the existing evidence, see if they are operating in evidence-rich or evidence-scarce environments, and prioritize the generation of new evidence for climate change adaptation.

Our joint report is just one step in our vision to achieve sustainable development and contributes to our respective missions to assess development and climate change interventions, and to provide evidence for improving policymaking.

Prof Dr Jörg Faust
Director
German Institute for Development Evaluation (DEval)

Dr Jyotsna Puri
Head
Independent Evaluation Unit (IEU)
Green Climate Fund (GCF)

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Abstract

In the face of the predicted and actual severity of climate change, there has been considerable interest in understanding what does and does not work to increase the ability of human and environmental systems to adapt to changing climate. This paper presents an evidence gap map and examines evidence on adaptation between 2007 and 2018. We analyse evidence related to the effectiveness of adaptation measures. The evidence gap map is derived from systematically and exhaustively reviewing adaptation-related high-quality evidence from evaluation and research in developing countries, from both peer-reviewed and grey literature. The resulting literature was mapped onto a conceptual framework that included the type of intervention, the sector of activity and types of outcome measured. We examined 464 papers in detail. The results show that there is a large share of adaptation-related evidence on agriculture, and within it on the economic returns of technological and nature-based solutions. The main evidence gaps include a scarcity of evidence on adaptation interventions in the water sector, and on measures aimed at reducing exposure to climate events. We also note there is a scarcity of studies that examine social and institutional outcomes of climate-change adaptation interventions. Not surprisingly, there are few studies that use experimental designs. Most studies use quasi-experimental designs and multivariate analyses. An online version of the evidence gap map can be found at: *https://egmopenaccess.3ieimpact.org/evidence-maps/adaptegmieu*.

We also introduce an innovation: In international development cooperation, ideally projects/investments should be evidence-based and effective. For countries, donors and development actors, a comparison of the project/investment portfolio with the available evidence in the form of an Intervention Heat Map (IHM) indicates whether the portfolio operates in evidence-rich or evidence-scarce fields. It helps prioritizing the generation of new evidence for climate change adaptation, either through rigorous impact evaluations or through evidence synthesis such as meta-analyses or in-depth reviews. This study provides this systematic overlay of the evidence gap map with the CCA portfolios of the GCF and Germany's bilateral commitments in international development cooperation (German Cooperation).

In concordance with the evidence, the IHM shows that much of the CCA portfolios cover agriculture and the sector relating to society, economy and health and promotes adaptive capacity. However, these projects/investments are also aiming to improve the enabling environment, where there is a lack of evidence, suggesting a possibility to improve upon and generate further evidence in the future. Furthermore, the IHM shows few project/investment interventions in the GCF and German Cooperation portfolios aimed at adoption of CCA and decreasing exposure of shocks and stressors as well as intervention types in the water and land use and built environment sectors, and project/investment interventions related to financial and market mechanisms and built infrastructure and structural interventions. Compared to the evidence, while there is a wealth of information on adoption and some on financial mechanism, these aforementioned limited project/investment interventions are also gaps in evidence. The allocation of funds is balanced among sectors but also seems to more match the nature of the intervention types.

The current evidence base on CCA suggests that efforts should be directed towards improving the evidence base in the water sector, which is one of the most important in CCA. Finally, given that the CCA portfolios examined mostly are aimed at outcomes within the enabling environment, evidence regarding these interventions should be improved. This is also the case for other areas where projects/investments are allocated but evidence is lacking.

Zusammenfassung

Mit Blick auf das prognostizierte und tatsächliche Ausmaß des Klimawandels ist es von großem Interesse, zu verstehen, welche Maßnahmen die Anpassungsfähigkeit menschlicher und ökologischer Systeme an den Klimawandel erhöhen und welche nicht. In der vorliegenden Studie wird eine *Evidence Gap Map* (EGM - Karte der Evidenzlücken) erstellt, die anschaulich zeigt, wo Evidenz zur Effektivität von Anpassungsmaßnahmen verfügbar ist und wo Lücken bestehen. Sie ist das Ergebnis einer umfassenden und systematischen Analyse von qualitativ hochwertiger Evidenz zwischen 2007 und 2018. Die Daten stammen aus Evaluierungen und Forschungsarbeiten zu Maßnahmen in Ländern mit niedrigem und mittlerem Einkommen, aus begutachteter sowie aus grauer Literatur. Diese Literaturquellen wurden in einer konzeptionellen Matrix abgebildet, die Interventionstypen, Anpassungssektoren und Kategorien der Wirkungen umfasst. Insgesamt wurden 464 wissenschaftliche Arbeiten im Detail ausgewertet. Dabei wurde deutlich, dass ein Großteil der Evidenzdaten zur Anpassung an den Klimawandel in der Landwirtschaft und hier vor allem zu den wirtschaftlichen Erträgen technologischer und naturbasierter Lösungsansätze zu finden ist. Die zentralen Evidenzlücken zeigen sich vor allem in geringen Erkenntnissen über Anpassungsinterventionen im Wassersektor und über Maßnahmen mit dem Ziel die Exposition gegenüber Klimaereignissen zu verringern. Außerdem gibt es nur eine geringe Anzahl an Studien, die die sozialen und institutionellen Wirkungen von Anpassungsmaßnahmen im Zusammenhang mit dem Klimawandel untersuchen. Erwartungsgemäß setzen nur wenige Untersuchungen experimentelle Designs ein. Die Mehrzahl der Studien arbeitet mit multivariaten Analysen oder quasi-experimentellen Designs. Eine Online-Version der Karte der Evidenzlücken ist verfügbar unter: *https://egmopenaccess.3ieimpact.org/evidence-maps/adaptegmieu*.

Zusätzlich wird eine Innovation eingeführt: Im Idealfall sollten Projekte/Investitionen in der internationalen Entwicklungszusammenarbeit evidenzbasiert und effektiv gestaltet werden. Ein Vergleich des Projekt-/Investitionsportfolios mit den verfügbaren Evidenzen in Form einer *Intervention Heat Map* (IHM – Karte der Interventionsmaßnahmen) signalisiert den beteiligten Ländern, Gebern und Entwicklungsakteuren, ob ihr Portfolio in evidenzstarken oder evidenzschwachen Bereichen agiert. Dies unterstützt sie dabei, Prioritäten bei der Generierung neuer Evidenz für Maßnahmen zur Anpassung an den Klimawandel zu setzen, entweder durch wissenschaftliche, rigorose Wirkungsevaluierungen oder durch Evidenzsynthese wie Meta-Analysen oder vertiefende Reviews. Die vorliegende Studie bietet diese systematische Verknüpfung der EGM mit dem Investitionsportfolio des *Green Climate Fund* (GCF) und dem bilateralen Projektportfolio Deutschlands zur Anpassung an den Klimawandel in der internationalen Entwicklungszusammenarbeit.

Die IHM verdeutlicht übereinstimmend mit den vorliegenden Evidenzdaten, dass viele Projekte/Investitionen der Portfolios zur Anpassung an den Klimawandel den Landwirtschaftsbereich und den Sektor mit gesellschaftlichem, wirtschaftlichem und gesundheitlichem Bezug abdecken und Anpassungsfähigkeiten fördern. Diese Projekte/Investitionen zielen jedoch auch auf die Verbesserung des förderlichen Umfelds ab, wozu bisher Evidenzlücken existieren. Dies weist auf eine künftige Möglichkeit zur Optimierung und Generierung weiterer Evidenzen hin. Darüber hinaus bildet die IHM nur wenige Projekt-/Investitionsmaßnahmen in den Portfolios des GCF und der deutschen Entwicklungszusammenarbeit ab, die auf eine Aufnahme von Anpassungsaktivitäten an den Klimawandel, eine Reduzierung der Exposition gegenüber klimatischen Schocks und Stressoren sowie Interventionen in den Bereichen Wasser- und Landnutzung, sowie bebaute Umgebung abzielen. Ebenso wenige richten sich auf Projekte/Investitionen im Rahmen von Finanz- und Marktmechanismen, Infrastrukturmaßnahmen und strukturellen Interventionen. Gemessen am Evidenzumfang gibt es zahlreiche Evidenzen bezüglich der Aufnahme von Anpassungsmaßnahmen und einige zu Finanzmechanismen. Die vorgenannten begrenzten Projekt-/Investitionsmaßnahmen weisen jedoch ebenfalls Evidenzlücken auf. Die Mittelzuweisung ist sektoral ausgewogen, entspricht aber auch mehr den unterschiedlichen Interventionstypen.

Der aktuelle Stand der Evidenzbasis zu Anpassungsmaßnahmen an den Klimawandel verdeutlicht, dass diesbezügliche Aktivitäten auf eine Verbesserung der Evidenzlage im Wassersektor, einem zentralen Bereich der Anpassung an den Klimawandel, ausgerichtet werden sollten. Angesichts der Tatsache, dass die untersuchten Portfolios zur Klimawandelanpassung auf Wirkungen im Rahmen eines förderlichen Umfelds ausgerichtet sind, sollte die Evidenzlage bei diesen Interventionen verbessert werden. Dies gilt auch für andere Bereiche, in denen Projekte/Investitionen vergeben werden, für die jedoch keine oder wenige Evidenzen vorliegen.

Contents

Figures

Table

Abbreviations

BMZ	German Federal Ministry for Economic Co-operation and Development
CCA	Climate Change Adaptation
DEval	German Institute for Development Evaluation
DRR	Disaster Risk Reduction
EGM	Evidence Gap Map
FFA	Forestry, Fishing and Agriculture Sector
GCF	Green Climate Fund
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IE	Impact Evaluation
IEG	Independent Evaluation Group
IEU	Independent Evaluation Unit
IHM	Intervention Heat Map
IPCC	Intergovernmental Panel on Climate Change
LBE	Land-use and Built Environment Sector
NGO	Non-governmental Organization
OECD	Organisation for Economic Co-operation and Development
PICO	Population, Intervention, Comparison and Outcomes
SEH	Society, Economy and Health Sector
UNFCCC	United Nations Framework Convention on Climate Change
WAT	Water Sector
WMO	World Meteorological Organization

INTRODUCTION

Climate Change Adaptation (CCA) has become a key topic in international development cooperation, with growing investments and projects in recent years.[1] Development and climate change are inextricably linked because the poorest people and least developed regions currently suffer the most from climate change impacts (IPCC, 2018). Low- and middle-income countries are more vulnerable to the impacts of climate change not only due to their development status but also because these countries are often also highly exposed to climatic hazards.

In the face of the predicted and actual severity of climate change, there is a rising demand for understanding what the evidence and evidence gaps are on increasing the ability of human and environmental systems to adapt to climate change in low- and middle-income countries. Evidence on the effectiveness of CCA interventions is essential to improve current and inform future projects/investments[2]. A global overview of the evidence for adaptation interventions has been lacking despite an increasing evidence base. The objective of this evidence gap map (EGM) on CCA is to take stock of high-quality evidence regarding the ability of adaptation interventions to help people in low- and middle-income countries adapt to the impacts of climate change.

EGMs are thematic collections of evidence focusing on a particular issue, mapping completed and ongoing systematic reviews and impact evaluations. The underlying conceptual framework is key and evidence is consolidated in an organized matrix. EGMs show in what sectors, interventions, and outcomes evidence is available and where there are gaps. It enables relevant stakeholders to explore the findings and quality of existing CCA evidence, inform areas for further research, and support evidence-based policymaking by informing the design and implementation of adaptation interventions.

However, EGMs present evidence neutrally and provide no explanatory power on the effect size of the interventions. EGMs do not indicate whether the evidence supports the relationship between an intervention and an outcome (i.e. has a positive effect overall), if the evidence has a negative relationship or if there's no relationship at all (i.e. there is no significant effect). For this, further meta-analyses or reviews of mapped articles are necessary.[3]

We also introduce one other innovation in this paper. In all public policy making, but especially in international development cooperation with scare resources for addressing complex global problems, projects/investments are ideally evidence-based and effective. For countries, donors and development actors, a comparison of the project/investment portfolio with the available evidence can indicate how evidence-based the portfolio is. This enables planners and decision-makers to see where more evidence needs to be generated and where projects/investments are backed by evidence. The result is an intervention heat map (IHM): a systematic overlay of the project/investment portfolio with the evidence base. However, such a systematic comparison does not exist even for some of the most sophisticated players in international development cooperation. This study thus fills this void by providing intervention heat maps for the CCA portfolios of the GCF and Germany's bilateral commitments in international development cooperation (German Cooperation).

The structure of the report is as follows: In part I, we develop, present, and discuss the global EGM of CCA in low- and middle-income countries. In part II of the report, we present two IHMs. The report concludes with implications from the EGM and IHMs and provides an outlook.

[1] This development has at least two reasons: First, interventions for climate change mitigation and CCA are of increasing importance. Second, climate change have come much more into focus, and funds and studies are getting tagged as 'climate' or 'adaptation' rather than development.

[2] Under the term "project" we subsume projects, programmes and measures. By "investment" we refer to investments, funds and grants.

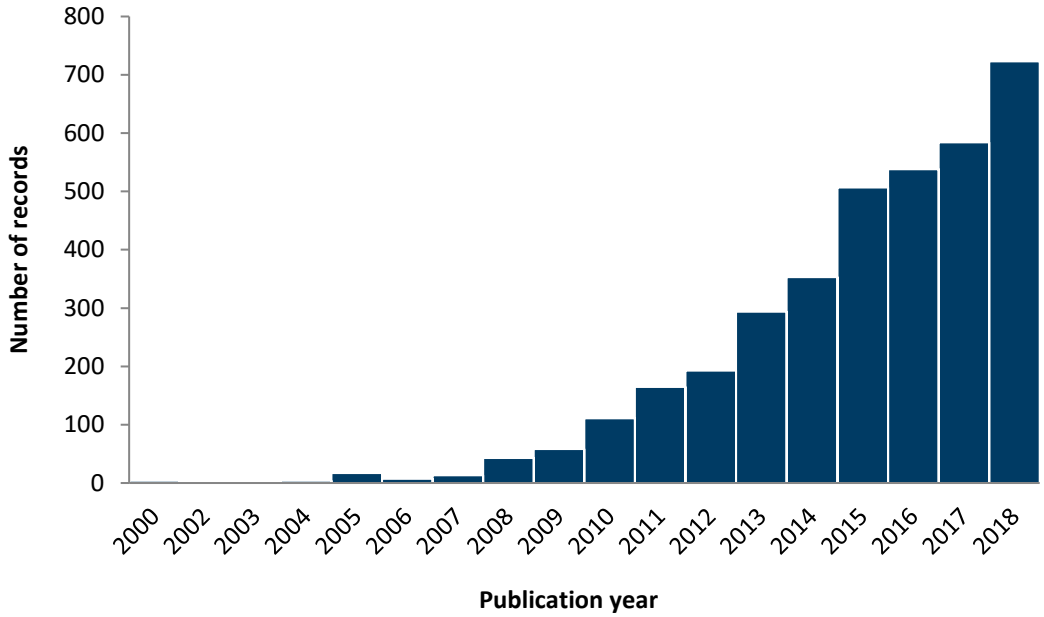
[3] Please see a sequel DEval Discussion Paper on the 'Access to credit as a determinant of autonomous adaptation to climate change: A meta-analysis of the evidence in low- and middle-income countries' where we present and discuss a meta-regression approach and its results in this sector.

PART I: EVIDENCE GAP MAP OF CLIMATE CHANGE ADAPTATION

A. Introduction

With widespread climate change impacts affecting all aspects of human life across the globe, the need to proactively adapt to our changing climate has been recognized and promoted by the UNFCCC and specifically in the Paris Agreement (UNFCCC, 2015). The first Intergovernmental Panel on Climate Change (IPCC) report to address the issue of CCA was the 4th Assessment Report (IPCC, 2007). Since that date, the number of projects and publications addressing CCA has grown exponentially (see Figure 1).

Figure 1 Number of publications or "records" from 2000–2018 that appear on the Web of Science, associated with the search term "climate change adaptation"



Source: authors' own figure, with data from Web of Science.

An increasing number of multilateral funding is being devoted to adaptation. The current GCF portfolio (March 2019) includes 102 projects with a total investment of USD 5.3 billion. Of this, only 37% is allocated to adaptation.[4] The bilateral climate finance portfolio of German Cooperation also has substantially increased between 2011 and 2017 according to OECD-CRS data, both for mitigation and adaptation. By 2017 annual commitments were already at three billion Euro, and so the target value of annual commitments of four billion Euro is likely to be met by 2020. Nearly half of German Cooperation's total climate financing was earmarked for adaptation in 2017 (Noltze & Rauschenbach, 2019).

In light of increasing demands for adaptation financing, it is even more important to understand what works for adaptation, and specifically what is effective in increasing resilience and reducing climate risk. This is challenging, since understanding adaptation and classifying effective adaptation can be done in a variety of

[4] The share of adaptation allocation of the GCF is computed on basis of the nominal funds allocated to adaptation and cross-cutting projects by GCF, while for cross-cutting projects only shares of the adaptation related result areas were applied. For German Cooperation development measures, the share of adaptation allocation is computed according to the OECD-DAC Rio markers for climate: CLA-2 (adaptation as principal objective) and CLA-1 (adaptation as significant objective) marked projects, while CLA-1 project are discounted at 50 percent of the total volume.

ways (Adger et al., 2005; Berrang-Ford et al., 2015). This is compounded by the interrelated nature of climate, environment and society, and by the lack of data on and understanding of many of these interactions.

Consequently, there are many frameworks and guidance approaches for measuring CCA (e.g. Béné et al., 2015; Schipper & Langston, 2015; Silvestrini et al., 2015). While interventions dedicated solely to adaptation are relatively new, adapting to climate variability has a long history (Doswald et al., 2014). The disaster-risk reduction field also contains relevant evidence, since there is a link between climate change and disasters from hydro-meteorological hazards (IPCC, 2012). Although there is a large amount of high-quality and grey literature, evidence is often scattered between sources and there is a lack of comprehensive and systematic synthesis (Berrang-Ford et al., 2015). In 2015, Berrang-Ford et al. found a total of 27 systematic reviews on CCA.

EGMs and systematic reviews have the potential to inform policy, research and evaluations by enabling practitioners to use existing evidence. According to Snilstveit et al. (2013), EGMs are thematic evidence collections covering a particular issue (e.g. agriculture or forestry) which consolidate the available evidence in a particular sector or sub-sector, by mapping completed and ongoing systematic reviews and impact evaluations in that sector. In summary, EGMs and systematic reviews:

- Provide an accessible overview of evidence from systematic reviews and impact evaluations;
- Highlight available evidence and its characteristics, such as ratings of confidence in systematic reviews;
- Allow users to explore the evidence base and findings of relevant studies;
- Reflect relevant interventions and outcomes associated with a particular area, and are structured around a framework (matrix);
- Populate areas with available studies and reviews, while highlighting “absolute gaps” related to impact evaluations and systematic reviews; and
- Highlight “synthesis gaps,” especially where there is a concentration of impact evaluations but no recent high-quality systematic review.

According to Snilstveit et al. (2013), EGMs facilitate evidence-based decision-making in the design and implementation of projects/investments by identifying both the evidence and the gaps in the evidence base related to a specific area. They are increasingly being applied in the evaluation contexts of development cooperation (e.g. by World Bank), with sectors such as health, agriculture and sanitation having already been evaluated using EGMs.[5] However, there is a lack of EGMs in the field of CCA, despite increasing evidence for their necessity.

[5] See, for example, the 3ie repository.

1. Objectives of the EGM

This report draws on the conceptual approach and methods paper of an EGM on CCA (Doswald et al., submitted), and discusses results. It addresses the primary question: What is the state of evidence on adaptation interventions, and what is their effectiveness in helping people in low- and middle-income countries adapt to climate change (see Table 1)?

Table 1 Main elements of the EGM on adaptation to climate change (the PICO framework)

POPULATION	INTERVENTION	COMPARATOR	OUTCOME
Humans, groups, communities, institutions, systems and sectors (water, transport, infrastructure, agriculture, forestry, etc.) in low and middle income countries.	Interventions that aim to adjust to, reduce, stop or benefit from a direct change in climate or a climatic hazard.	No adaptation intervention; different levels of intervention; or comparison of different interventions.	Human adaptation to climate change, variability, extremes or other natural hazards that could be linked to climate change.

Source: Doswald et al., submitted.

The overall outcome in Table 1 is broad and leaves room for accommodating different elements of CCA, such as reducing climate change impacts or increasing adaptive capacity.

To understand the extent of evidence related to CCA – including what sort of evidence exists and relevant gaps – we followed the following steps:

a) Developed a clear framework of interventions and outcomes from the state of evidence regarding the ability of adaptation interventions to help people in low and middle income countries adapt to the impacts of climate change (see Doswald et al., submitted)

b) Developed a search protocol for systematic reviews and primary studies (see Doswald et al., submitted)

c) Mapped available systematic reviews and primary studies using this framework and protocol

These are discussed in the following sections.[6]

2. Definitions and Concepts

Climate change can be defined as alterations to global and regional climates caused by an anthropogenic increase in greenhouse gases (Bindoff & Stott et al., 2013), when compared to a baseline climate. The reference baseline period of 1961 to 1990 has usually been favoured (IPCC, 2013; WMO, 2017). Climate change is currently occurring and is projected to cause a general increase in global temperatures, changes in precipitation patterns, sea level rise, glacial melt and an increase in climate-related hazards such as heat waves, flooding, droughts and storms.

Climate change has many further impacts which can cause secondary hazards (e.g. mudslides, landslides) and repercussions such as the spread of invasive species and reductions in agricultural yield. However, these secondary hazards and impacts are the result of an interplay between many factors, including land use and population increase. In these cases, attributing impacts solely to climate change – or even sometimes implicating climate change – can be difficult. Indeed, invasive species might spread because they have been introduced to a country by tourists carrying food, and agricultural yield may fail because of this newly

[6] This paper draws largely from Doswald et al. (submitted).

introduced invasive species. Invasive species may also spread because the changing climate allows them to enter new areas, and agricultural yield may fail either due to this or to drought.

CCA has been defined and used differently by various authors and organizations (see for example Schipper, 2007; Moser & Ekstrom, 2010). Table 2 details the definitions used in the climate change policy context. Definitions vary and the first key words in the differing definitions of adaptation – such as "adjustment," "practical steps," "process" and "outcome" – can be interpreted differently depending on the stakeholder (Levina and Tirpak, 2006).

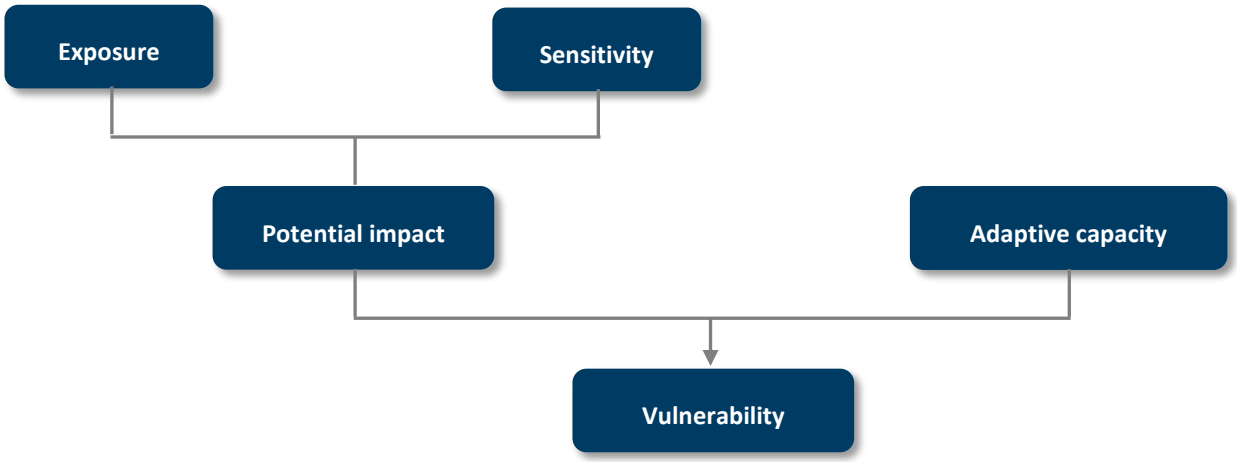
Table 2 Common policy definitions of climate change adaptation

ORGANIZATION/AUTHOR	DEFINITION
Intergovernmental Panel on Climate Change	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2014).
IPCC, also used by the United Nations Framework Convention on Climate Change	Adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (UNFCCC website, 2020; IPCC, 2001).
United Nations Development Programme	Process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed and implemented (UNDP, 2018).

The definition used in this report follows the IPCC Fifth Assessment Report (AR5, 2014). CCA is defined as the process of adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Two frameworks from the IPCC Fourth Assessment Report (AR4, 2007) and the Fifth Assessment Report (AR5, 2014) are relevant for building an EGM framework (Figures 2 and 3).

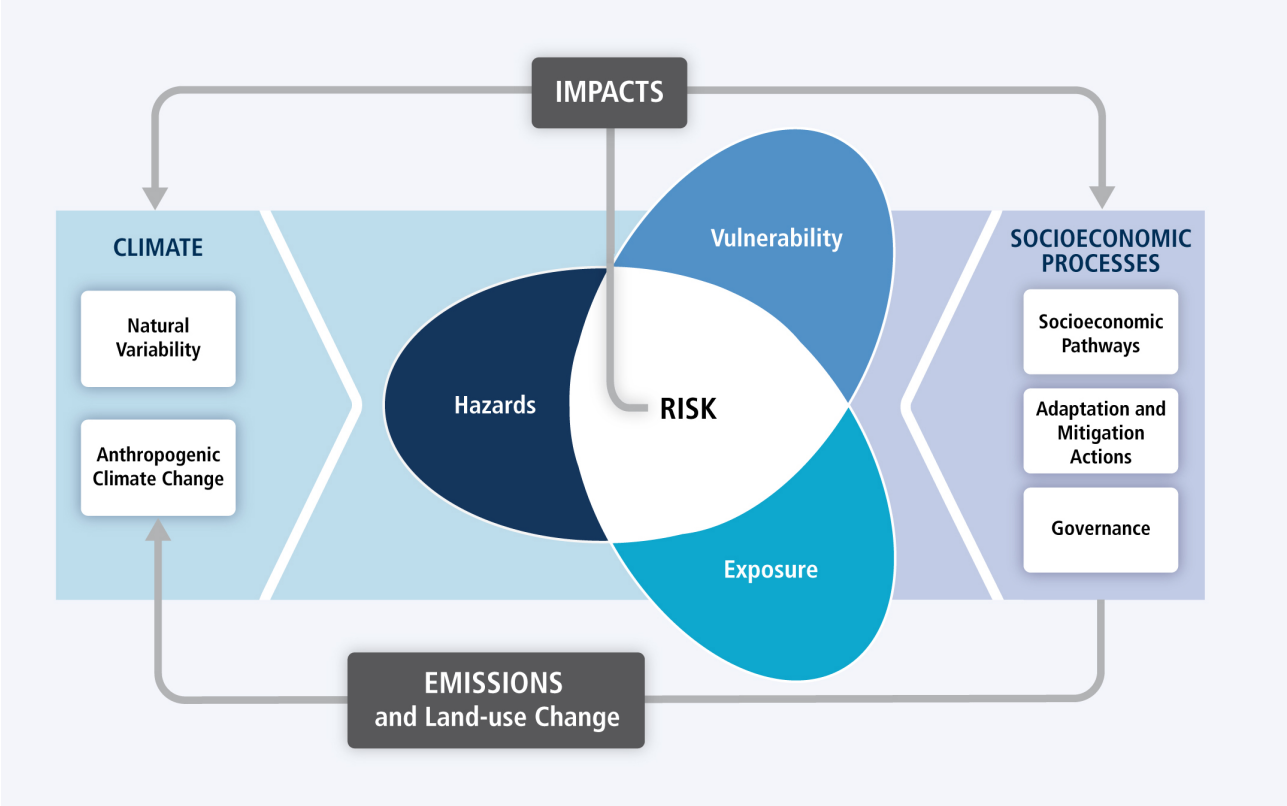
As can be seen from Figures 2 and 3, the term vulnerability is described differently between AR4 and AR5. In AR5, the concept of "risk" introduces new terms and definitions for old terms, but allows for a different way of looking at CCA. A key difference is that the notion of "exposure" has been taken out of being part of vulnerability in AR5, and vulnerability includes sensitivity and lack of adaptive capacity. We use a combination of both definitions for the EGM to develop our framework of outcomes. From AR4 we use the three pillars under which CCA outcomes are structured: (a) exposure to shocks and stressors; (b) adaptive capacity; and (c) sensitivity, which is related to the enabling environment. We also include the notion of risk as defined in AR5 by including impacts of climate change. The use of these conceptual frameworks for developing our outcomes for the EGM on CCA will be discussed further in section B.

Figure 2 Framework of vulnerability to climate change, from IPCC (2007)



Notes: *The AR4 defines the following:*
Vulnerability *is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change, and variation to which a system is exposed, its sensitivity and its adaptive capacity.*
Source: *authors' own figure based on IPCC (2007).*

Figure 3 Framework of risk from climate change, from IPCC (2014)



Notes: *The AR5 defines the following:*
Risk *is the potential for consequences (= impacts) where something of value is at stake and where the outcome is uncertain (recognizing the diversity of values), and is often represented as the probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure and hazard.*
Vulnerability *is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.*
Source: *IPCC (2014, p. 3).*

Complications in understanding and defining CCA in practice arise because of the linkages between climate, society and environment, and thus with development. Links between environmental policy, environmental management and social policy and actions, also combine to influence the impact of climate change on people either positively or negatively. Adaptation to climate change therefore encompasses a wide range of interventions and expected outcomes. Furthermore, it can be difficult to measure the effectiveness of adaptation given the uncertainty around how to define *effective* adaptation. Within this, climate projections also vary in quality and in confidence (Williams & Jackson, 2007). Thus, for instance, an adaptation measure that is effective now may not be effective in the future. An *effective intervention* can be defined as one that achieves its stated objectives. Effectiveness may be framed according to the specific objectives of CCA (Villanueva, 2011) – that is, reducing risk, building adaptive capacity or increasing resilience. However, effectiveness may also depend, for example, on the level of uncertainty involved. An "effective" adaptation, particularly for socioeconomic interventions, is one that is flexible to change in response to altered circumstances and is therefore robust against uncertainty.

B. The EGM Framework

Developing a framework for the EGM requires identifying a relevant set of interventions and outcomes for CCA. However, adaptation to climate change is necessarily a multi-sectoral issue, with each sector requiring a different set of interventions and outcomes (IPCC, 2014). Furthermore, what can be called effective adaptation is not straightforward given uncertainty, the time lag for interventions to show their potential effectiveness and the potential of maladaptation (Adger et al., 2005; Hallegatte, 2009; Eriksen et al., 2011; Ford et al., 2013). Additionally, as discussed above, there are linkages between CCA and sustainable development, whether these have been implicitly or explicitly framed in the climate change literature, policy and implementation (Schipper, 2007; WRI, 2007; Eriksen et al., 2011). This then determines what is classified as an adaptation intervention as well as CCA evidence (Ford et al., 2013).

1. Adaptation Sectors and Interventions

Sectors

There are a number of sectors exposed to the impacts of climate change and variability, such as agriculture and forestry, water infrastructure, land-use planning, coastline and flood defences, building and housing, transportation infrastructure, urbanism, and energy production (Hallegatte, 2009). The majority of German Cooperation adaptation financing is implemented in the sectors (according to OECD definitions) of agriculture, environmental protection, and water (Noltze & Rauschenbach, 2019). As shown in Table 3, different multilateral organizations consider different sectors for CCA.

Table 3 Multilateral organizations and sectors considered for adaptation

ORGANIZATION	SECTOR, AREA OR THEME
Adaptation Fund	Sectors: Agriculture, food security, coastal zone management, water management, multi-sector, rural development, disaster risk reduction, forests, urban development (Adaptation Fund, 2020).
The Organization for Economic Co-operation and Development	Examples of typical sectors: Flood prevention/control, agriculture, fishing, forestry, disaster prevention and preparedness, water and sanitation, health (OECD, 2011).
Green Climate Fund	Results areas: Health, food and water security; livelihoods of people and communities; infrastructure; ecosystems as four pure adaptation result areas; four mitigation result areas as partial result areas (as GCF allows for cross-cutting projects); forests and land use; buildings, cities, industries; energy; transport (GCF, 2020).
Global Environment Facility	Priority areas: Agriculture and food security, Water resources management, Coastal-zone management, Infrastructure, including transport and energy, Disaster risk management, Natural resources management, Health, Climate information services, Climate-resilient urban systems (GEF, 2014).

For the purposes of this EGM, we examine evidence for interventions in four sectors (see population, intervention, comparator and outcome (PICO) in Table 1), namely:

a) water (WAT)

b) forestry, fishing and agriculture (FFA)

c) land use and built environment (LBE)

d) society, economy and health (SEH)

This creates mutually exclusive and yet exhaustive categories for us to understand and map evidence.

Interventions

There are different ways to classify adaptation interventions, in that they are likely to either decrease sensitivity, reduce exposure or increase resilience (Adger et al., 2005). After analysing adaptation projects, Biagini et al. (2014) use a typology of adaptation actions. We use this typology for the EGM (see Table 4).

Table 4 Intervention type and related adaptation activities, climate change adaptation EGM

INTERVENTION TYPE	DEFINITION
Nature-based options	Activities that make use of ecosystems and biodiversity as well as sustainable management, conservation and restoration of ecosystems.
Built infrastructure/structural	Activities that include structural components.
Technological options	Activities that include technology.
Informational/educational	Activities that aim to inform or educate.
Institutional/planning/policy/ laws/regulations	Activities that include policies, plans, standards or regulations.
Financial/market mechanisms	Activities that include financial transactions or are market driven.
Social/behavioural	Activities that include social support and change or behavioural change.

Source: Adapted from Biagini et al. (2014).

For each intervention type, we included activities that directly address climate and weather events even if they are not labelled as adaptation, as well as activities that are undertaken under CCA projects (see Table 9 for details on inclusion criteria). When including interventions, we focus specifically on outcome-based approaches rather than process-based approaches (see Ford et al., 2013, for a discussion on these two types), because only outcome-based approaches can realistically be employed as evidence for two reasons (Silvestrini et al., 2015). First, process-based approaches are generally long-term and slow, and may not have visible outcomes (Ford et al., 2013). Second, process-based approaches are too proximate in the causal chain to enable an examination of causal evidence (see, for instance, Zhang et al., 2011).

Interventions are classified into sectors and intervention types using this structure. An example of this is cash transfers for agricultural purposes being classified as financial instruments under agriculture, forestry and fishing. Disaster risk reduction (DRR) interventions are cross-sectoral and nested in various interventions and sectors. In the EGM, water-related DRR interventions are therefore classified according to whether the target of the intervention is water resources (in which case it would be included under the water sector) or if the targets are people and infrastructure (in which case they are included in the built-environment sector). Table 5 gives details on the classification of sectors and interventions. We used the same classification of intervention types in each sector so as to enable a comparison between sectors, even if it is acknowledged that some intervention types are used more often in some sectors than others. However, it is feasible to find interventions of each type within all sectors, as can be seen in Table 5.

Table 5 Interventions by sector and intervention type, climate change adaptation EGM

SECTOR	INTERVENTION TYPE	EXAMPLES OF ADAPTATION INTERVENTIONS
Water	Nature-based options	Wetland restoration; water conservation; river restoration; nature weirs; integrated water management; watershed management.
	Built infrastructure/structural	Dams, dykes, weirs, drainage systems, wells.
	Technological options	Desalination technology.
	Informational/educational	Water conservation education, flood information, early-warning systems
	Institutional/planning/policy/laws/regulations	Water policies, regulations.
	Financial/market mechanisms	Payment for ecosystem services; water payment; insurance for flooding.
	Social/behavioural	Migration due to floods/drought; social support due to floods/drought.
Forestry, fishing and agriculture	Nature-based options	Intercropping; conservation agriculture; changing planting dates; agroforestry; conservation tillage; bunds; traditional seeds/varieties; rain-fed irrigation; crop rotation; sustainable forestry and fishing.
	Built infrastructure/structural	Seed banks, wind shelters.
	Technological options	Drought-tolerant varieties, GMO, irrigation, fertilizer.
	Informational/educational	Extension services, trainings, information, early warning.
	Institutional/planning/policy/laws/regulations	Agricultural laws, NGO/government programmes.
	Financial/market mechanisms	Weather insurance, credit, subsidies.
	Social/behavioural	Cooperatives, informal groups.

SECTOR	INTERVENTION TYPE	EXAMPLES OF ADAPTATION INTERVENTIONS
Land-use and built environment	Nature-based options	Restoration; conservation; sustainable management; mangroves; sand dunes or marshes for coastal protection; integrated coastal zone management; green roofs/walls; green infrastructure; green and blue space in cities.
	Built infrastructure/structural	Sea walls, hazard-proof buildings, insulation for buildings.
	Technological options	Air-conditioning, cooling systems.
	Informational/educational	Sustainable management trainings, coastal early warning.
	Institutional/planning/policy/laws/regulations	Zoning; land use plans; regulations and standards for buildings; government and NGO input.
	Financial/market mechanisms	Payment for ecosystem services.
	Social/behavioural	Support groups, migration from coastal areas.
Society, economy and health	Nature-based options	Nature management for vector control; nature-based/ecological livelihood diversification.
	Built infrastructure/structural	Shelters for disasters.
	Technological options	Bednets, etc. for mosquitos; early-warning technology/mapping.
	Informational/educational	Health-related information/education; financial information.
	Institutional/planning/policy/laws/regulations	Vulnerability-reducing programmes; DRR laws and regulations; vaccination programmes; essential public health services; enhanced emergency medical services.
	Financial/market mechanisms	Cash transfers, credit, microcredit.
	Social/behavioural	Psychotherapies; livelihood diversification; household preparation and evacuation planning; social networks, social safety nets and social protection; food banks and distribution of food surplus; governance programmes.

Source: Adapted from Biagini et al. (2014) with examples from Biagini et al. (2014) and IPCC (2014).

2. Adaptation Outcomes

CCA outcomes vary depending on the sector and the interventions (see Table 6 for some examples of different sector-intervention outcomes), potentially further complicating the development of the EGM framework, which aims to "use a theory-based approach with a focus on outcomes along the causal chain" (Snilstveit et al., 2013, p.8).

Table 6 Illustrative climate change outcomes for the sectors used in the EGM

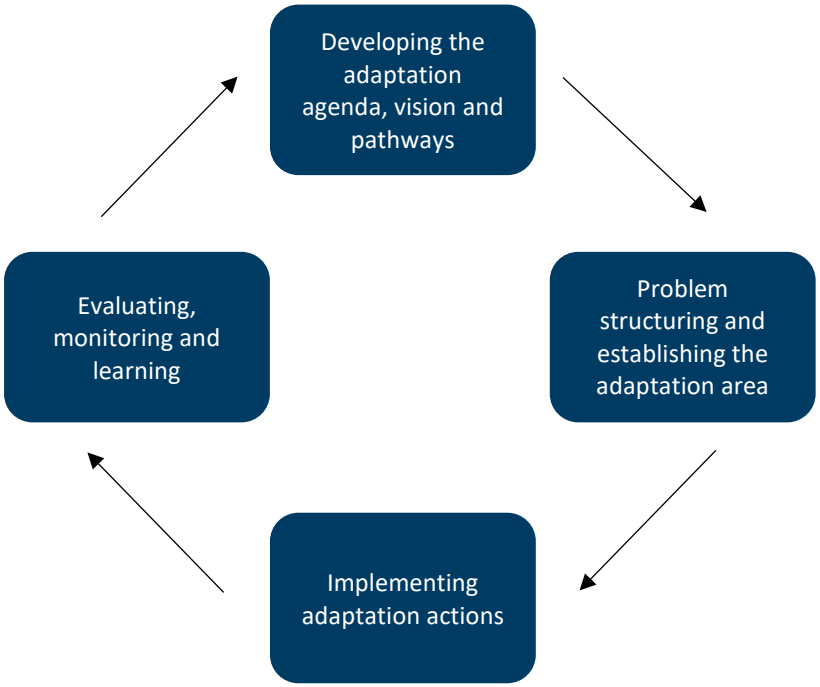
SECTORS	ILLUSTRATIVE CCA OUTCOMES
Water	Availability and access is maintained or enhanced. Quality is maintained or enhanced. Risks to human lives, infrastructure, economy, etc. are decreased.
Land-use and built environment	The built environment is cooler (heat island effect is reduced). The built environment is more resistant to climatic impact. Risks to human lives, infrastructure, economy, etc. are decreased.
Forestry, fishing and agriculture	Forests are sustainably managed and protected. Food security is assured. Yield is maintained or increased. Alternative livelihoods using natural resources are used.
Society, economy and health	Society is more aware of CCA and DRR. Society is protected financially under climate change events. Social policy is in place. People are evacuated and relocated safely. Disease spread is controlled. Disaster-related health issues are decreased.

Source: Adapted from Doswald et al., submitted.

A theory of change and a resulting outcome framework for projects provides a road map for how goals will be achieved, and can be helpful in its provision of a comprehensive picture (Bours et al., 2014). However, these take time to develop and can be reductionist in complex problems where the process is not linear and is uncertain, such as in CCA (Conservation International, 2013). Importantly, most CCA literature agrees that the adaptation process is more cyclical than linear (see Figure 4), because a learning component is necessary given the uncertainty of future climate change and the potential for novel climatic conditions (Williams and Jackson, 2007). This makes it more difficult to create a linear theory of change for the EGM.

To summarize, there are many difficulties associated with collecting evidence related to CCA. These include: not having a commonly well-accepted definition of adaptation; no clear, universal understanding of effective adaptation; uncertainty regarding future climate change (and therefore problems knowing if adaptation is occurring at all); understanding links between the drivers of CCA change, CCA interventions and outcomes; and, a lack of an agreed framework or theory of change for CCA. We use IPCC frameworks (Figures 2 and 3) as well as a more general understanding of adaptation and resilience, in line with the definition of CCA, in the broader context of sustainable development (Figure 5) to produce a framework for CCA interventions and outcomes.

Figure 4 Schematic representation of the Adaptation Action Cycles



Source: Adapted from Park et al., 2012

The framework in this paper takes into account exposure and impacts/risks, adaptive capacity, and the creation of change in the enabling environment that in turn accommodates the notion of exploiting beneficial opportunities. We also include other attributes in the EGM. Schipper (2007) argues that sustainable development is a necessary precondition for CCA and Béné et al. (2015) highlight the importance of considering "enabling environments (e.g. service delivery, governance, infrastructure, policies, access to social protection)" for systemic change, and a consideration of "positive synergistic effect on the absorptive and adaptive capacities of households, communities, and higher-level systems" (p.10). In trying to create a suitable grouping of outcomes, we classify outcomes under the following headings:

a) **Responses to shocks and stressors**: These outcomes relate to the ability of targeted groups to address shocks and stressors while minimizing permanent, negative effects on their longer-term livelihood security. These outcomes include those related to DRR and disaster risk management approaches.

b) **Increased adaptive capacity**: These outcomes relate to the ability of targeted groups to make pro-active and informed decisions about alternative livelihood strategies based on an understanding of changing conditions.

c) **Enhanced enabling environment**: These outcomes include system-level changes in the environment, the socio-economic system and the institutional environment that enable more and lasting resilience.

It should be noted that, before these outcomes can occur, adaptation interventions need to be adopted, and thus the uptake of adaptation options is also important as an outcome. Adoption studies that include interventions that are likely to support the **uptake of adoption**-related interventions are included. Studies that we exclude are those that examine autonomous adoption (see for example Herminia et al., 2011). These studies examine determinants of adoption, and do not specifically measure causal impacts of interventions. Instead they investigate the correlation between different levels of intermediate outcomes.

Figure 5 Outcomes based on the IPCC definition and frameworks

Source: Adapted from Doswald et al., submitted, based on IPCC definition and frameworks.
Note: Outcome cells considered in this study are in dark blue.

Outcomes are further divided into sub-categories to reflect outcome indicator types (Table 7). Outcomes can be positive, negative or neutral.

Table 7 Outcomes and sub-categories

OUTCOME	SUB-CATEGORIES
Uptake	Adoption
Shocks and stressors	Increased/decreased exposure Increased/decreased impacts/risks
Adaptive capacity	Social benefits Economic benefits
Enabling environment	Environmental systems Socioeconomic systems Institutional systems

Source: Adapted from Doswald et al., submitted.

3. Framework

Our framework has a 3-D structure with sectors, interventions and outcomes (see Table 8).

Table 8 Evidence gap map framework for climate change adaptation

CLIMATE CHANGE ADAPTATION		UPTAKE	SHOCKS AND STRESSORS		ADAPTIVE CAPACITY		ENABLING ENVIRONMENT		
Sectors	Outcomes / Interventions	Adoption	Exposure	Impacts/risks	Social benefits	Economic benefits	Environmental systems	Socioeconomic systems	Institutional systems
Sectors	Illustrative outcome indicators		Population affected by extreme weather	Risk management; climate-related illness; deaths; food security	Skills acquired, awareness	Livelihood, productivitiy, access to credit	Area protected; ecological services	Social capital; overall poverty measurements	Policy changes; regulations; institutional reform
Water	Nature-based options								
	Built infrastructure/structural								
	Technological options								
	Informational/educational								
	Institutional/planning/policy/laws/regulations								
	Financial/market mechanisms								
	Social/behavioural								
Forestry, fishing and agriculture	Nature-based options								
	Built infrastructure/structural								
	Technological options								
	Informational/educational								
	Institutional/planning/policy/laws/regulations								
	Financial/market mechanisms								
	Social/behavioural								
Land-use and built environment	Nature-based options								
	Built infrastructure/structural								
	Technological options								
	Informational/educational								
	Institutional/planning/policy/laws/regulations								
	Financial/market mechanisms								
	Social/behavioural								
Society, economy and health	Nature-based options								
	Built infrastructure/structural								
	Technological options								
	Informational/educational								
	Institutional/planning/policy/laws/regulations								
	Financial/market mechanisms								
	Social/behavioural								

C. Review

A systematic map protocol was used, which followed guidelines set out by the Centre for Evidence-Based Conservation (CEE, 2018). Several databases (Web of Science, Scopus, 3ie database and CEE library) and grey literature from several organizational websites were systematically searched using this search protocol (see Annex 1). Searches were performed in English and identified all literature that had an English abstract. Some articles, however, were in different languages and were included if they were in Spanish, French or German; otherwise they were excluded. The inclusion/exclusion criteria are summarized in Table 9.

Table 9 Inclusion and exclusion criteria

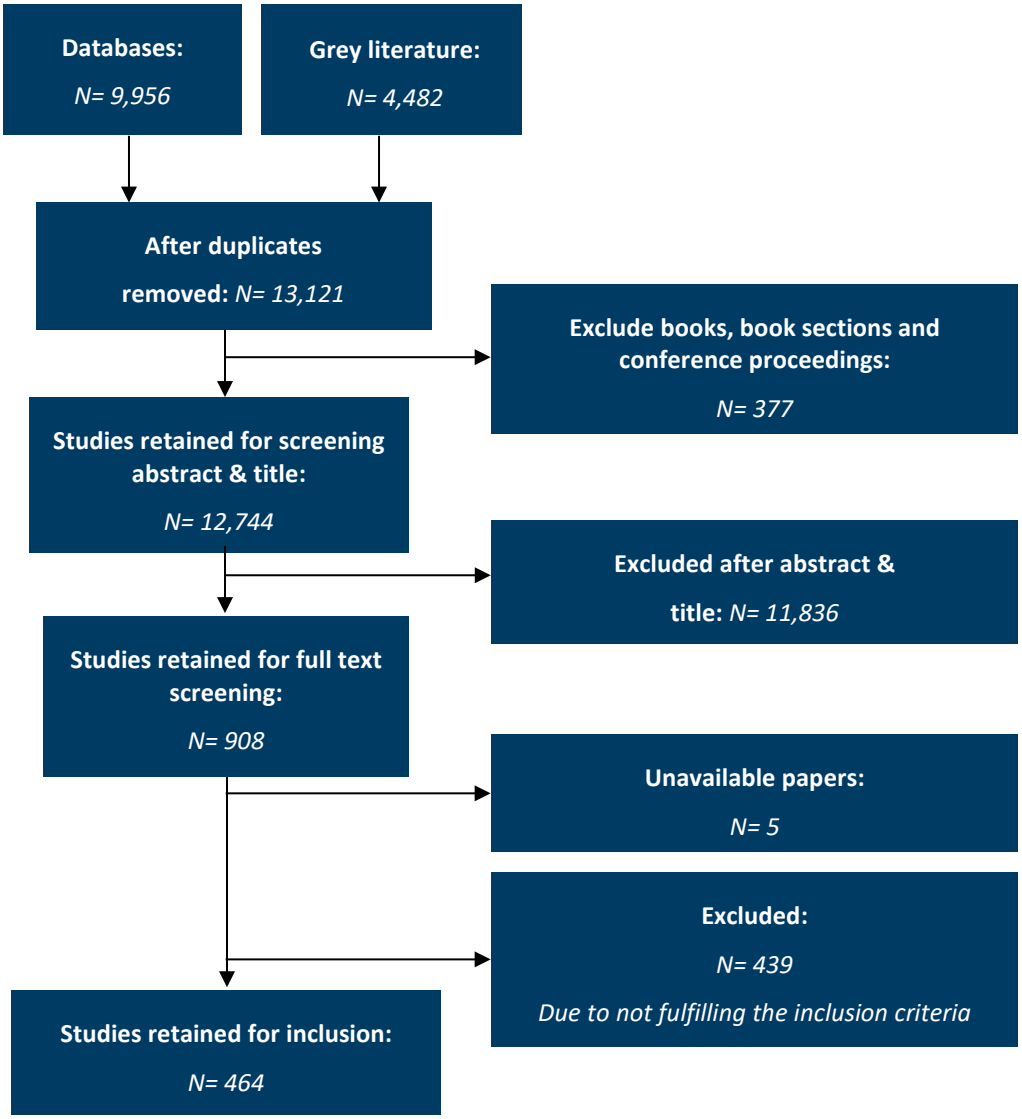
INCLUSION CRITERIA	EXCLUSION CRITERIA
Relevant subject (population) People in low- and middle-income countries as defined by OECD: human individuals, groups, institutions, systems, communities and economic sectors (water, transport, infrastructure, agriculture, forestry, etc.).	**Irrelevant subject (for this EGM)** Evidence not from an OECD low- and middle-income country. Studies where plants, animals and ecosystems are the focus, with no human element. Evidence that does not concern climate. Evidence that concerns climate change mitigation rather than adaptation. Evidence that focuses on impacts of climate change rather than adaptation to climate change.
Relevant interventions Those that aim to adjust, reduce, stop or use the benefits from changes in climate or a climatic hazard due to climate change in different sectors. (There needs to be a link to a climatic factor or hazard within the study, or reference to CCA.)	**Irrelevant intervention (for this EGM)** Any nature conservation adaptation intervention (e.g. to conserve particular species of conservation interest). (There has to be a link to human systems adaptation.) Any intervention that does not have a direct link to adjusting to a climatic stimulus.
Relevant comparator No adaptation intervention, different levels of intervention, and comparison between interventions.	**Irrelevant comparator (for this EGM)** Where no measure of success of the adaptation intervention was presented and compared with no adaptation intervention, or different levels of intervention.
Relevant outcome Those that address vulnerability, either through risk or exposure, adaptive capacity or enhancing the enabling environment.	**Irrelevant outcome (for this EGM)** Vulnerability assessments.
Relevant study Quantitative or mixed-methods studies. Systematic reviews. Correlation analyses (e.g. using cross-sectional data, panel data or time series). Impact evaluation (IE) approach, which assesses the impact of an intervention using counterfactual analysis (experimental and quasi-experimental approaches).	**Irrelevant study (for this EGM)** Comparisons of modelling techniques. Process-based evaluation reports (i.e. evaluation reports based on milestone indicators, stakeholder-based evidence and qualitative information). Prospective and predictive analysis based on modelling. Cost-benefit analysis. Articles published before 2007 and after 2018. Languages outside those in the inclusion criteria.

INCLUSION CRITERIA	EXCLUSION CRITERIA
Articles published between 2007 and 2018. Language of article with English abstract: English, French, Spanish and German. Published peer-review articles and published grey literature (documents published by organizations).	Books or book sections.

Source: Adapted from Doswald et al., submitted.

The search found a total of 13,121 papers. Once duplicates had been removed and after screening according to exclusion criteria, 464 were included (see Figure 6 for a PRISMA diagram). [7]

Figure 6 Inclusion exclusion diagram



Source: authors` own figure

[7] An online version of the EGM with a full overview of all included papers can be found at: *https://egmopenaccess.3ieimpact.org/evidence-maps/adaptegmieu*.

Fleiss's Kappa analysis was undertaken to test reviewer rating agreement at the abstract filtering stage. Kappa values range from +1 to −1, with anything less than 0 indicating no agreement (Landis and Koch, 1977), with values 0.60–1.00 rated as indicating sufficient agreement between the reviewers. The Kappa score obtained between the three reviewers in this study was 0.64.

D. Data Coding and Analyses

Included papers were given an identifier number and all bibliographic information was recorded in a spreadsheet database. Each paper was analysed to identify all the pieces of evidence[8] generated by the studies, generating a second database in the form of a coding sheet which included several fields relevant to the gap-map analysis: (1) World Bank region; (2) country; (3) population sub-group; (4) sector; (5) intervention type; (6) intervention; (7) outcome; (8) outcome sub-group; (9) outcome indicator; (10) study design; and (11) methods. Fields 1, 3, 4, 5, 7, 8 and 10 were coded numerically to allow descriptive statistics, while fields 2, 6, 9 and 11 were coded descriptively (see Annex 2). The EGM was populated with the number articles that were coded in each intervention/outcome cell. One single article can be found coded into several cells in the EGM if they contain different interventions and/or outcomes.

E. Results

1. Geographic Distribution

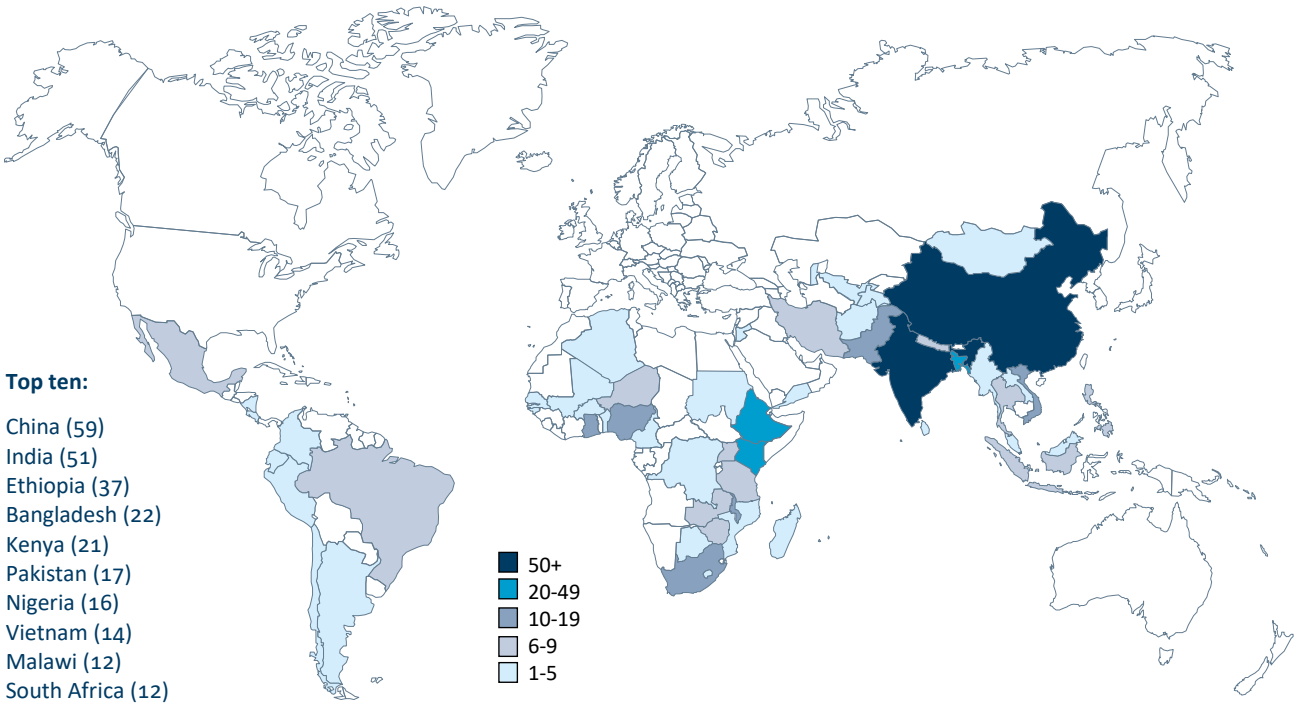
Out of the 464 included research papers, 39.7 per cent pertained to interventions in Sub-Saharan Africa, followed by East Asia and the Pacific, and South Asia, both with around 22 per cent (see Table 10). Latin American countries were the area of study in 5.8 per cent of the cases, whereas Central Asia, and the Middle East and North Africa only received 0.4 per cent and 2.4 per cent of the total research, respectively. Some 37 papers (8.0 per cent of the total) provided evidence of CCA interventions at global or multi-regional level. It is interesting to note that out of the 407 single-country papers identified, 63.0 per cent of these were located in just 10 countries, meaning empirical evidence on CCA is highly concentrated around a limited number of countries (Figure 7).

Table 10 World Bank regions focused on by included papers

WORLD BANK REGION	NUMBER OF PAPERS	PERCENTAGE
Sub-Saharan Africa	184	39.7
South Asia	102	22.0
East Asia & Pacific	101	21.8
Global/multi-region	37	8.0
Latin America & Caribbean	27	5.8
Middle East & North Africa	11	2.4
Central Asia	2	0.4
Total	**464**	**100.0**

[8] When we use “pieces of evidence”, we refer to the number of times an intervention type has been mapped to an outcome in the EGM matrix.

Figure 7 Geographic distribution of single-country papers, with top ten countries



Source: Authors' own figure.

2. Sectors, Interventions and Outcomes

Table 11 below shows the distribution of evidence within the EGM. Each cell contains the number of articles that test for a relationship between the intervention/outcome described by that cell. We add a third level of classification where we group each intervention type by sector, and outcomes are grouped by broader categories as discussed above. The density of available evidence in the selected literature is depicted by an intensity colour scale in each cell: the darker the colour, the higher the number of articles collected for that particular sector, intervention and outcome.

The EGM presented in Table 11 is also accessible online. The online version of the EGM provides links to all included papers. The online EGM can be accessed here: https://egmopenaccess.3ieimpact.org/evidence-maps/adaptegmieu.

Table 11 Evidence gap map – number of papers for each intervention type and outcome, by sector

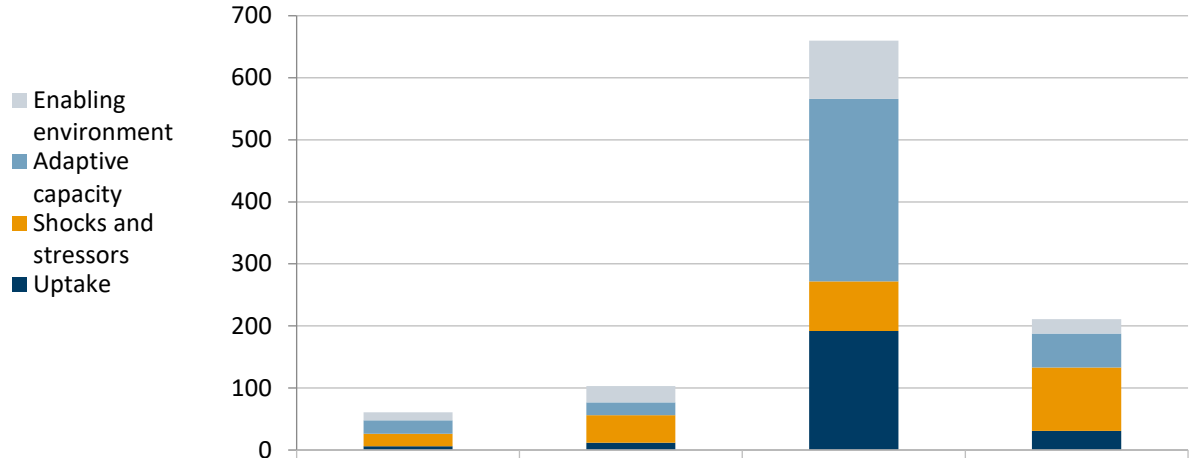
EVIDENCE GAP MAP		UPTAKE	SHOCKS AND STRESSORS		ADAPTIVE CAPACITY		ENABLING ENVIRONMENT		
	INTERVENTION/OUTCOMES	Adoption	Decreased exposure	Decreased Impacts/Risks	Social benefits	Economic benefits	Environmental systems	Socioeconomic systems	Institutional systems
SECTORS	Example specif ic outcomes indicators	Uptake	Population affected by extreme weather events	Proactive and reactive risk management; climate related illness; deaths; food security	Skills acquired, access, awareness	Livelihood diversification, productivitiy gains, access	Area protected, ecological services improved	Social capital enhanced, overall poverty measurements	Policy changes, regulations approved, institutional reform
Water	Nature-Based Options				1	3	3		
	Built Infrastructure / Structural	1	1	10	2	9	3	2	
	Technological Options			1		1	1		
	Informational/ Educational	2		3		1	1		
	Institutional/ Planning/ Policy/ Laws/ Regulations	1		3	1	2			
	Financial/ Market Mechanisms	1		1			2		
	Social/Behavioural	1		1	1	1	1		
Land-use and Built Environment	Nature-Based Options	1	14	4	1	3	2	1	
	Built Infrastructure / Structural	3	4	4		5	3	1	
	Technological Options			1			3		
	Informational/ Educational	3		4	1		3		
	Institutional/ Planning/ Policy/ Laws/ Regulations	2	3	2	1	4	4	2	2
	Financial/ Market Mechanisms	2		2	1		2		
	Social/Behavioural	1	1	5	3	2	2	1	
Forestry, Fishing and Agriculture	Nature-Based Options	3	2	29	2	106	34	8	
	Built Infrastructure / Structural	11		5	1	9	1		
	Technological Options	7	2	19	2	100	17	5	
	Informational/ Educational	77	1	7	9	19	5	5	
	Institutional/ Planning/ Policy/ Laws/ Regulations	14		3	1	5		3	
	Financial/ Market Mechanisms	44	1	6	4	14	4	5	
	Social/Behavioural	36		5	3	19	4	3	
Society, Economy and Health	Nature-Based Options	1		3	1				
	Built Infrastructure / Structural	1		9		3			
	Technological Options			8				1	
	Informational/ Educational	9	2	10	8	2		1	
	Institutional/ Planning/ Policy/ Laws/ Regulations	2	1	15		4		2	2
	Financial/ Market Mechanisms	5	1	26	1	14	1	5	1
	Social/Behavioural	13	2	25	5	17	1	6	3

Out of the 464 research papers that met all of the inclusion criteria, a total number of 1,035 pieces of evidence have been coded and mapped according to the categories defined in the EGM framework. Since it is common that one single paper addresses the effectiveness of multiple interventions (and often in connection to several outcomes), the number of papers in each cell adds up to a substantially larger Figure than the total number of papers, with an average of 2.2 pieces of evidence per paper.

Results by sector

The area with the most concentration in the EGM is the forestry, fishing and agriculture sector (Figure 8), which is the subject of 295 articles and 660 pieces of evidence (Figure 8). Furthermore, the majority of articles relate to agriculture only.

Figure 8 Number of pieces of evidence by sector and overall outcome



	Water	Land-use and Built Environment	Forestry, Fishing and Agriculture	Society, Economy and Health
Enabling environment	13	26	94	23
Adaptive capacity	22	21	294	55
Shocks and stressors	20	44	80	102
Uptake	6	12	192	31

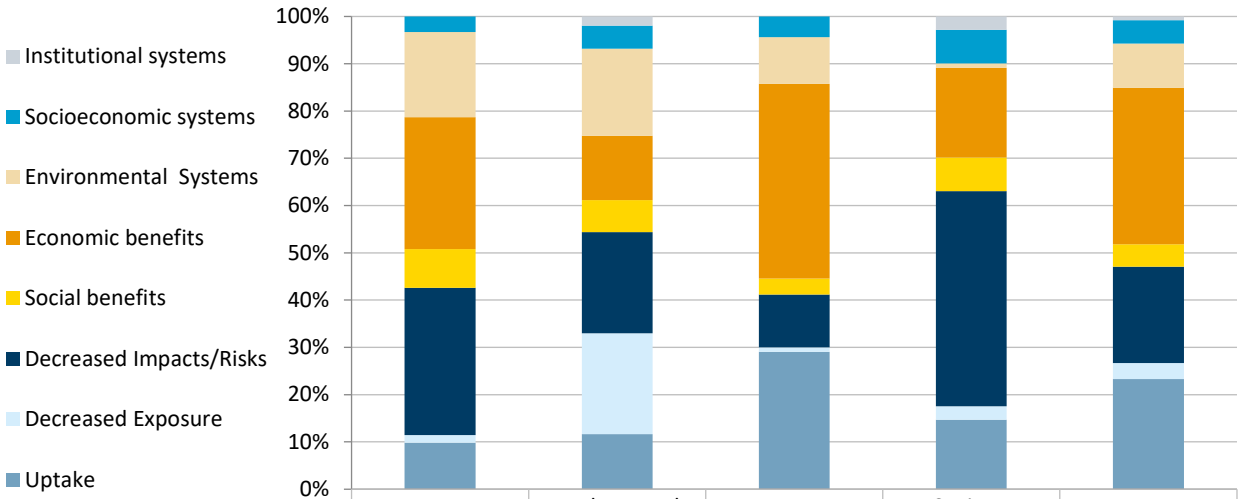
Source: authors' own figure.

The second-most populated sector of the EGM is society, economy and health, with 112 articles and 20.3 per cent of the collected evidence, followed by land-use and built environment, with 54 articles and 9.9 per cent of the evidence. Studies in SEH mainly address livelihoods and economic mechanisms, such as insurance or cash transfers, and a few papers address health interventions, particularly malaria or dealing with post-traumatic stress. Studies in LBE for the most part relate to early-warning systems, land use and management, land use policy and regulations, and green infrastructure (especially in urban areas). The water sector (WAT), which in the framework of CCA policies is considered to be a key issue, has been the subject of IE studies to a much lesser extent, with only 39 articles and a 6.0 per cent share of evidence. The types of studies recorded in WAT relate to watershed development, water-saving/collecting mechanisms, and access to water. It should be noted that evidence on the effectiveness of irrigation technologies and water infrastructure directly aiming to enhance agricultural productivity and resilience have been classified under the FFA sector in the EGM.

Results by outcome

Investigations related to outcomes surrounding shocks and stressors are the third most common area studied. The bulk of these investigations lie in the SEH sector, with 45.2 per cent of the evidence inspecting the reduction of impacts and risks (Figure 9). Shocks and stressors (decreased impact and exposure) are also the subject of a substantial number of papers in the LBE sector, although more in the form of exposure-related outcomes, something that seems to be consistent with the physical and structural nature of the sector.

Figure 9 Distribution of evidence by outcome category in each intervention sector



	Water	Land-use and Built Environment	Forestry, Fishing and Agriculture	Society, Economy and Health	Grand Total
Institutional systems		2		6	8
Socioeconomic systems	2	5	29	15	51
Environmental Systems	11	19	65	2	97
Economic benefits	17	14	272	40	343
Social benefits	5	7	22	15	49
Decreased Impacts/Risks	19	22	74	96	211
Decreased Exposure	1	22	6	6	35
Uptake	6	12	192	31	241

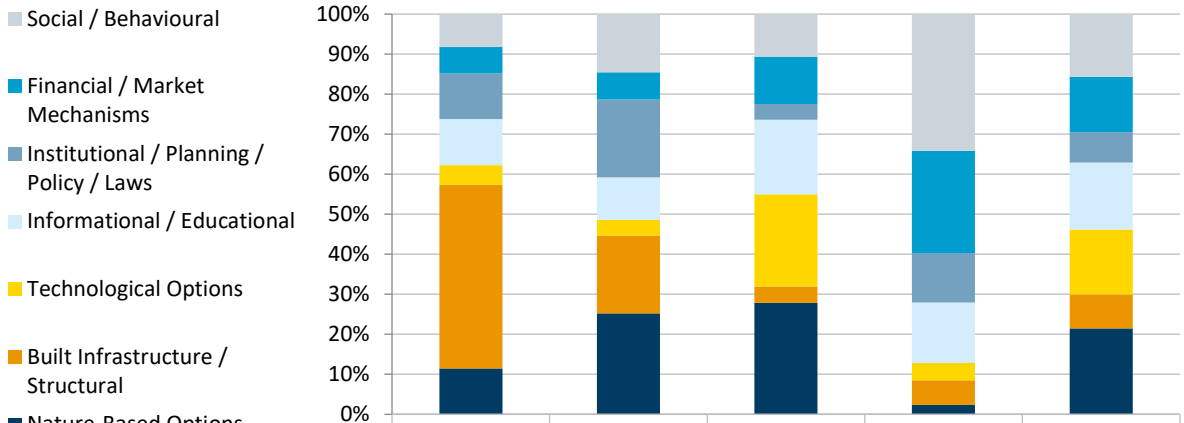
Source: authors' own figure.

The main gap in terms of outcomes studied is found in the "enabling environment" outcome, under the sub-outcome "institutional systems". There is a paucity of evidence for the enabling environment in general, although slightly more papers have investigated the impact on environmental systems. Further areas with very little evidence collected are the sub-outcomes "exposure" and "social benefits."

Results by intervention type

Figure 10 shows the distribution of the types of interventions studied within each sector. The distribution across different types of interventions does not show significant balance and therefore does not point to evident preferences of the literature towards certain measures. Nonetheless, some trends are worth noting. For example, out of the seven categories of interventions, nature-based solutions are the most frequent subject of study (with 21.5 per cent of the evidence), followed by educational and informational measures (16.7 per cent) and technological options (16.2 per cent). In contrast, the interventions that received the least attention from the literature refer to institutional, policy and legal measures (7.6 per cent), followed by infrastructural interventions (8.5 per cent).

Figure 10 Distribution of evidence by intervention type in each sector



	Water	Land-use and Built Environment	Forestry, Fishing and Agriculture	Society, Economy and Health	Total
Social / Behavioural	5	15	70	72	162
Financial / Market Mechanisms	4	7	78	54	143
Institutional / Planning / Policy / Laws	7	20	26	26	79
Informational / Educational	7	11	123	32	173
Technological Options	3	4	152	9	168
Built Infrastructure / Structural	28	20	27	13	88
Nature-Based Options	7	26	184	5	222

Source: authors' own figure.

As has already been pointed out, the literature from the WAT and LBE sectors has addressed infrastructural interventions to a significantly greater extent than it has in the FFA and SEH sectors, whereas these sectors are characterized by a high prevalence of financial mechanisms (such as cash transfers, credit and insurance) and social/behavioural interventions (such as livelihood diversification). On the other hand, FFA is clearly characterized by a higher presence of nature-based solutions (such as conservation agriculture and cropping systems) and technological options (such as irrigation, fertilizer and drought-resistant crops), whereas LBE is the only sector where the focused literature shows a substantial presence of institutional and legal measures (relating for example to land tenure or policies). Also worth noting is the fact that nature-based solutions – the most frequent type of intervention overall – are more commonly present in the FFA and LBE sectors, whereas technological options are more clearly concentrated in the former and are lacking in some other sectors. Interventions around policies and regulations have been the least studied in terms of impact.

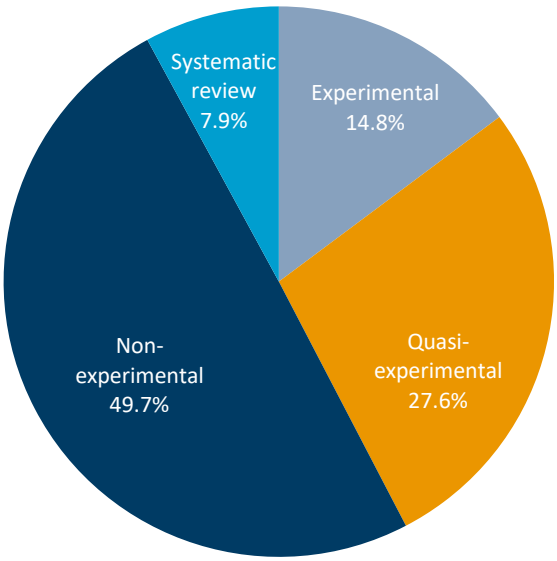
The area attracting by far the highest concentration of literature in the EGM (see Table 11) deals with the economic benefits provided by agriculture (nature-based solutions and technological options, with 106 and 101 papers addressing this issue, respectively). Adoption studies are the second-most numerous, and address interventions aiding the uptake of FFA interventions by mostly pointing to informational/educational measures (77 papers), financial and market mechanisms (44) and social/behavioural options (36). Finally, papers addressing the role of financial mechanisms and social/behavioural measures are concentrated in the

area of reducing climate-related risks and impacts within the SEH sector (26 and 25 articles, respectively). The rest of the EGM contains very few studies in comparison to the areas that have been noted above. In particular, evidence on the effectiveness of interventions targeting institutional systems across all sectors is almost completely missing, as well as studies addressing exposure outcomes in the water sector.

3. Study Design Types in the EGM

This report classified all individual articles into four potential categories: experimental (e.g. field experiments, randomized control trials), quasi-experimental (studies comparing non-random treatment versus non-treatment), non-experimental (studies employing correlation methods such as multivariate regression) and systematic reviews (which also include meta-analysis). Figure 11 shows the distribution of study designs within the set of collected evidences. As can be seen, nearly half the papers are non-experimental.

Figure 11 Percentage share of study design types within the collected evidence



Source: authors` own figure

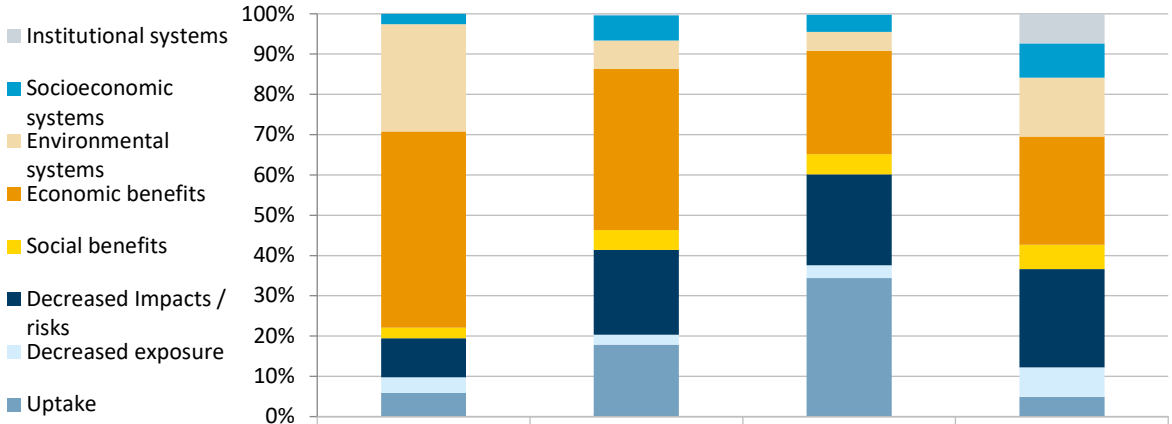
These mostly include correlation studies in the form of multivariate analysis and binomial regressions that investigate the causal relationship between certain intervention measurements (independent variables) and CCA outcome indicators (dependent variables), usually controlling for other factors in order to isolate the effects. In the case of adoption studies, which account for 34.4 per cent of the non-experimental designs (see Figure 12), the most frequent approach is the use of binomial regressions, in which the dependent variable captures the decision whether or not to adopt a particular CCA strategy, technology or intervention.

The second-most frequent study design consists of quasi-experimental approaches (27.6 per cent), mostly in the form of difference-in-difference regressions, matching techniques and endogenous switching models. These study types perform comparisons between two or several groups of subjects (farmers, households, individuals, territorial units, etc.) that are differentiated by the type of intervention received (or not received), but whose inclusion in one or another group has not followed a randomized design (i.e. experimental).

The use of experimental designs amounts to 14.8 per cent of the collected evidence, of which 70 per cent corresponds to agricultural trials that perform comparisons between treated and control plots of land. Hence, the proportion of experimental designs – such as randomized control trials (RCT) with human populations in the field of CCA – is very limited. Finally, systematic reviews amount to 7.9 per cent of the overall collected evidence. These are studies that perform any type of systematic meta-analysis of existing

evidence, whether they are empirical, quasi-empirical or non-empirical. An aspect worth noting is the fact that most of the evidence on institutional outcomes is addressed in systematic reviews (Figure 12; Table 12). The highest degree of concentration of systematic reviews is found with respect to the effects of nature-based solutions, particularly in the agricultural sector and in connection to their environmental benefits for adaptation.

Figure 12 Distribution of evidence by outcome in each study design type



	Experimental	Quasi-experimental	Non-experimental	Systematic review
Institutional systems		1	1	6
Socioeconomic systems	4	18	22	7
Environmental systems	41	20	24	12
Economic benefits	75	114	132	22
Social benefits	4	14	26	5
Decreased Impacts / risks	15	60	116	20
Decreased exposure	6	7	16	6
Uptake	9	51	177	4

Source: authors' own figure.

Across sectors, the percentage of studies in each design is similar. The WAT sector contains 13.1 per cent (8) experimental studies, 36.1 per cent (22) quasi-experimental studies, 44.6 per cent (27) non-experimental studies and 6.6 per cent (4) systematic reviews. The LBE sector contains 8.7 per cent (9) experimental studies, 21.4 per cent (22) quasi-experimental studies, 52.4 per cent (54) non-experimental studies and 17.5 per cent (18) systematic reviews. The FFA sector contains 17.1 per cent (113) experimental studies, 28.6 per cent (189) quasi-experimental studies, 48.9 per cent (323) non-experimental studies and 5.3 per cent (35) systematic reviews, and the SEH sector contains 11 per cent (23) experimental studies, 24.8 per cent (52) quasi-experimental studies, 52.4 per cent (110) non-experimental studies and 11.9 per cent (25) systematic reviews.

Table 12 Evidence gap map with evidence colour-coded by experimental design

EVIDENCE GAP MAP		UPTAKE				SHOCKS AND STRESSOR								ADAPTIVE CAPACITY								ENABLING ENVIRONMENT											
SECTORS	Intervention type/outcome category	Adoption				Decreased exposure				Decreased Impacts/risks				Social benefits				Environmental benefits				Environmental systems				Socieconomic systems				Institutional systems			
	Study Design	Ex	QE	NE	SR	Ex	QE	NE	SR	Ex	QE	NE	SR	Ex	QE	NE	SR	Ex	QE	NE	SR	Ex	QE	NE	SR	Ex	QE	NE	SR	Ex	QE	NE	SR
Water	Nature-Based Options														1				2	1		2	1										
	Built Infrastructure / Structural			1				1			2	8			2				4	5		1	1	1		1		1					
	Technological Options										1							1						1									
	Informational/ Educational			2						1	1		1							1		1											
	Institutional/ Planning/ Policy/ Laws/ Regulations			1							1		2		1				2													
	Financial/ Market Mechanisms			1								1											2										
	Social/Behavioural			1									1			1			1			1											
Land-use and Built Environment	Nature-Based Options		1			4	1	4	5		1	2	1		1				2		1		1		1		1					
	Built Infrastructure / Structural			2	1	2		1	1		1	3						1		4			1	1	1			1					
	Technological Options											1										2	1										
	Informational/ Educational			3							1	3				1							3										
	Institutional/ Planning/ Policy/ Laws/ Regulations			1	1		2	1				2					1		2	2			2	1	1			1	1				2
	Financial/ Market Mechanisms			1	1							2				1							2										
	Social/Behavioural		1					1			1	4			1	2				2			2				1						
Forestry, Fishing and Agriculture	Nature-Based Options		1	2			1	1		1	13	13	2			2		35	33	29	9	20	4	6	4		3	4	1				
	Built Infrastructure / Structural		3	8							2	2	1			1		2	2	4	1	1											
	Technological Options		3	4			1	1		1	8	9	1			2		33	29	34	4	12	4		1		3	2					
	Informational/ Educational		17	59	1		1			2	1	4			2	7		1	10	7	1	1	1	2	1		2	2	1				
	Institutional/ Planning/ Policy/ Laws/ Regulations		6	8							1	2				1			2	3							1	2					
	Financial/ Market Mechanisms	1	7	36			1				1	5			1	3		1	7	4	2		1	2	1		2	2	1				
	Social/Behavioural	1	6	29								5				3		1	6	11	1		1	1	2		2	1					
Society, Economy and Health	Nature-Based Options			1						1		1	1			1																	
	Built Infrastructure / Structural			1							4	5							1	2													
	Technological Options										1	5	2														1						
	Informational/ Educational	4	2	3				2		1	5	4		4	3		1		1	1						1							
	Institutional/ Planning/ Policy/ Laws/ Regulations		1	1				1		1	4	8	2						2	2								1	1				2
	Financial/ Market Mechanisms	1		4				1		5	6	14	1				1		5	7	2		1			1		3	1			1	
	Social/Behavioural	2	3	8				2		2	5	13	5		2	1	2		3	13	1		1			1	2	2	1		1		2

F. Discussion

1. Geographic Distribution

A high proportion of the papers were undertaken in Sub-Saharan Africa, which could be explained by a high interest in the drought and food security issues that have plagued that region. Both South Asia and East Asia are regions well represented in the gap map, although a large share of the evidence is concentrated around two single countries. Indeed, it is worth noting that a very limited number of countries have produced a large share of the total compiled evidence, with China (59) and India (51) already covering nearly 20 per cent of the literature on a global scale.

The low representation of Latin American countries in the EGM is unlikely to be a real gap, and might have been partially affected by the search strategy applied during the process. In particular, it is reasonable to think that an important share of the relevant evidence in the field might have been published in Spanish-language journals that our search protocol was not able to capture. This is due to the fact that all the search terms applied in the protocol were worded in English, for both academic and grey literature. Although a priori, it was expected that this strategy would be able to capture publications in Spanish that included at least abstracts and keywords in English, the low output of relevant papers in the region may suggest that literature in Spanish would require a specific search protocol in that language. The representativeness of evidence from Sub-Saharan Africa and the Maghreb could be also affected by the same problem, since the presence of French-speaking countries in the selected literature is very low (only nine articles for Sub-Saharan Africa). This would need to be taken into account for future attempts to systematically map or review evidence on related topics in the region.

2. Sectors, Interventions and Outcomes

The sectoral differences in terms of evidence reflect several issues. The first may be how much each sector provides ease of identification, that is, whether the sector is visibly affected by climate change. For example, the effects of climate change are much easier to identify in agriculture where weather patterns and climate shifts over decades are directly tied to the productivity of the sector. Furthermore, the high degree of dependence on natural resources and the relative weight of agriculture in the economies of developing countries (see Table 13) has commonly marked the policy agenda on CCA, especially as this sector is highly vulnerable to climate change, which could explain the high concentration of evidence around that sector in the EGM. Another aspect that may have influenced the research interest in agriculture could be the relative importance placed on how to encourage the uptake of adaptation measures in this field. Research on adoption, as well as on autonomous adaptation, has been stimulated by a need to better understand the main drivers and interventions behind the decisions to adapt made by farmers and households with fragile livelihoods. This is reflected in the high presence in the FFA sector of adoption studies (under the adoption outcome). The majority (79.9 per cent) of adoption studies are concentrated in the FFA sector.

Table 13 Relative weight of FFA sectors in GDP, by country income level

COUNTRY INCOME CLASSIFICATION	AGRICULTURE; FORESTRY AND FISHING; VALUE ADDED (PERCENTAGE OF GDP)
High income	1.3
Upper middle income	6.4
Middle income	8.4
Lower middle income	15.1
Low income	25.1

Source: World Bank Open Data.[9]

A UNFCCC analysis of 148 Nationally Determined Contributions showed that the priority areas in CCA are, in order of priority, water, agriculture, health, ecosystems and infrastructure (UNFCCC, 2017).

Given the importance of water, the lack of IEs found in this sector is surprising. Possible explanations for this may include irrigation technologies being placed under the FFA sector, with another possible explanatory factor being the debatable suitability of ex-post impact evaluation approaches in connection to certain research fields. In reviewing the literature, it was observed that interventions with an important infrastructure component were less prone to being the subject of this type of analysis, as they are favoured by other types of research such as cost-benefit analysis, predictive modelling and ex-ante impact assessments. Indeed, implementing large projects such as drainage systems or transport infrastructure is expensive and disruptive, and ex-ante studies are therefore commissioned prior to their undertaking (Griskeviciene et al., 2012). Furthermore, for many sectoral projects, it is more important to establish the evaluation of potential effects, such as whether a dyke can withstand a certain amount of water (Venable et al., 2016). Hence, sectors that by nature are more reliant on these types of interventions (WAT and LBE a priori) seem to have received less attention from impact-evaluation literature. Although modelling and predictive techniques are also commonly applied in connection to cropping systems, particularly for the simulation of crop yields in different climate scenarios and interventions, other typically common interventions from the WAT and LBE sectors are better suited for this approach given the significant sunk costs of investment that are usually required. This would be the case in civil engineering solutions for coastal management, land use transformation programmes, or integrated water systems.

The paucity of information on decreased exposure partly reflects the lack of impact evaluations undertaken in the field of DRR (S. Bennett, personal communication[10], 2019), and also the fact that most papers evaluate decreased impact rather than decreased exposure, which is potentially easier to measure. Nevertheless, this is a gap that is important to fill. The exception were papers evaluating the impact of nature-based solutions to decrease exposure, particularly the role of mangrove forests. The area of utility for nature-based solutions has increased since the advocacy of ecosystem-based approaches for adaptation arose in conjunction with adaptation policy developed under the UNFCCC (Vignola et al., 2009; Munang et al., 2013), which has stimulated research including a systematic review on ecosystem-based adaptation (Doswald et al., 2014).

A major gap in terms of outcomes is the impact on the enabling environment, particularly on institutional systems. This is concerning given the importance the enabling environment plays in vulnerability to climate-change adaptation – through poverty and governance issues, for example – and how efforts ostensibly are aimed at improving this (DasGupta & Shaw, 2017). It has to be noted, however, that a few good-quality

[9] World Bank Open Data, available at *https://data.worldbank.org/.*

[10] DEval-Campbell Collaboration Conference. *Using evidence for more effective policy and practice: the role of evidence synthesis*. Bonn. 9-10 May 2019.

qualitative studies in this area do exist (e.g. Roling, 2016; Schaer and Hanonou, 2017), which were excluded due to their non-quantitative character.

The uneven distribution of interventions across sectors may reflect either the nature of the sector or, on the contrary, the presence of certain research priorities and gaps in the literature. In this regard, it should be noted that each sector of the EGM framework has been configured with a symmetric structure, namely with the same categories of interventions in each of them. Therefore, one can reason that differences in the number of collected evidences across interventions cannot solely be attributed to research preferences, but also to the specific needs and challenges of each sector. For instance, it is reasonable to think that the WAT and LBE sectors are by nature more reliant on structural interventions than other sectors, whereas the reliance of the SEH sector on financial and behavioural measures is expected to be greater. However, a more conclusive assessment can only be performed in the light of an in-depth understanding of the actual portfolio of interventions put out by national and international actors, as well as of the set of adaptive measures implemented by affected people as spontaneous responses.

Interventions around policies and regulations have been the least studied in terms of impact, which given their importance as regulatory mechanisms represents a gap. It may be the case that this type of intervention does not necessarily lend itself as well to impact evaluations as it does to qualitative analysis, although quantitative studies are feasible. Furthermore, regulatory mechanisms are usually measured by process-based indicators which were not included in this study. The lack of evidences on technological options in either the WAT or LBE sectors is surprising. It could be that our search strategy did not pick those up, or that in low- and middle-income countries technological options are less current or at least less studied in relation to CCA.

3. Study Design Types in the EGM

The number of papers would have been reduced by half if correlation studies (quantitative evidence without an experimental or quasi-experimental design) had been excluded. Experimental designs are not always common when studying social and environmental systems (Baldasarri et al., 2017), which was one of the reasons for including this type of data. It is noteworthy that the majority of experimental studies are agricultural field trials. RCTs in the social field have been performed for CCA, notably in studying the impact that information has on insurance uptake or in relation to studies testing the performance of therapy to alleviate post-traumatic stress after floods. Nevertheless, for certain types of interventions – such as those aimed at decreasing disaster risk – RCTs may be less easy to perform or could entail ethical implications (O'Mathúna, 2010), which would explain why fewer RCTs have been performed in certain sectors. Adoption studies and those relating to financial and social interventions are mostly non-experimental, for which common outcome variables in intervention-related studies would include composite indices on food security, household resilience and vulnerability, and health-related outcomes. Cash transfers and access to different modalities of credit are the most commonly assessed economic interventions, whereas livelihood diversification strategies are the most frequently assessed social interventions.

The quality of all evidence within the EGM would need to be assessed if more in-depth analyses such as systematic reviews or meta-analyses were employed.

G. Implications

This study constructed a framework to evaluate the state of the evidence base for CCA, in terms of interventions and outcomes in four sectors. Based on this framework, an EGM was developed comprising a total of 1,035 pieces of evidences gathered in 464 papers, to identify the main gaps in evidence.

1. Water Sector

This sector contains the least evidence in the EGM. The types of studies recorded relate to watershed development, water-saving/collecting mechanisms and access to water. However, the water sector is vast and is impacted by climate change, and therefore this gap in evidence is problematic. As stated in the discussion, some of these gaps could be due to ex-ante modelling studies being undertaken in this field rather than impact evaluations. It would therefore be worth undertaking either an EGM or systematic reviews that look at these types of studies – and which include an evaluation of whether any validation of the models was undertaken – as they could provide useful information with regard to the effectiveness of interventions that may not have been subject to impact evaluations. However, impact evaluations for interventions in this sector are feasible but have rarely been carried out.

A policy implication is that the effectiveness of current interventions is not backed up by rigorous evidence; thus, to have more confidence in their effectiveness, more rigorous impact evaluations need to be generated in this sector.

2. Land Use and Built Environment Sector

This sector is the second-least populated sector in the EGM. Studies recorded in this sector mainly relate to early-warning systems, land use and management, land-use policy and regulations, and green infrastructure (especially in urban areas). As with the water sector, infrastructural interventions are usually evaluated ex ante. However, given the potential of interventions in this sector to reduce exposure and impact to climate change, there should be greater efforts to evaluate the effectiveness of these DRR measures, without which it is difficult to have confidence in the effectiveness of these interventions.

3. Forestry, Fishing and Agricultural Sector

The agricultural sector has been intensively researched. Mostly, the interventions relate to either nature-based topics such as sustainable agriculture, or to technological interventions such as drought tolerant species, and their outcomes tend to focus on food security (decreased impact outcome) or income (economic benefit outcome). The evidence points to well-researched mechanisms for adapting to climate change in this sector, as shown by the numerous experimental field trials and impact evaluations. Field experiments have also allowed for the impact on the environment to be measured to some extent.

During the review, it was found that the field of adoption studies that focuses mostly on autonomous adaptation is quite wide, with many articles on this subject being excluded as they did not study specific interventions aimed at uptake, but rather focused on the determinants of adoption, including factors that might predispose one to choose to adapt. However, given the breadth of this field and the few systematic reviews on the subject that are available, this might be an area that could lend itself to synthesizing the evidence.

The main gaps in this sector relate to outcomes on reduced exposure, social benefits and institutional systems. These could be an artefact of the types of studies undertaken in this field. However, it would be worth considering these aspects in future projects.

In contrast, forestry and fishing are virtually absent from the EGM. Ideally, more impact evaluations should be performed to back up interventions in these areas with evidence on their effectiveness.

4. Society, Economy and Health Sector

This sector is the second-most populated in the EGM and covers a wide range of papers, addressing livelihoods (society), economic mechanisms such as insurance or cash transfers, and health interventions, particularly those dealing with malaria or post-traumatic stress. The majority of interventions studied focus on decreasing the impacts of climate change. Contrary to other sectors, environmental outcomes have not been studied, possibly because the interventions may not have been thought to have had an environmental outcome or they had one too far removed in the causal chain. There have been a few more studies on institutional outcomes in the form of governance. As stated in our discussion, qualitative studies – especially for societal, policy or institutional change aspects – are more suitable, and these were excluded in our EGM as it looked only at quantitative evidence. However, many aspects of CCA, for example vulnerability or resilience, cannot be captured solely by quantitative terms (Kelman et al., 2017). It would therefore be worth either undertaking an EGM or systematic reviews that include these types of studies, to answer particular questions relating to societal, policy and institutional change. Without looking into these, it would be difficult to fully understand the effectiveness of CCA.

5. Limitations

There are a few limitations to this study. One was the potential underrepresentation of studies in which English is not the primary academic language, and which might have been better captured using non-English search terms. Another limitation is the very broad range of classifications for interventions and outcomes, which allows for a wide overview and comparability between sectors but perhaps obscures some of the detail that could have been captured by a more specific sectoral adaptation gap map. This is particularly true of the SEH sector, which is potentially three sectors in one, and thus includes a wide variety of interventions grouped within each instrument type.

The EGM can reveal gaps and concentration of evidence but cannot indicate the causes behind them, and therefore only hypotheses can be generated. Furthermore, for the topic of CCA, any intervention studied can only provide information for a particular point in time under a particular context. It cannot take into account the uncertainty inherent in CCA.

It is important to note that the EGM does not indicate whether the evidence shows that the interventions are successful or not (i.e. does not show the direction or magnitude of impact). The EGM only considers rigorous evidence, obtained mostly through quantitative data or in experimental settings. It is reasonable to think that some interventions are not entirely suitable for this kind of evaluation. Engineering projects, newly built or renewed infrastructure, as well as many governance related actions (e.g. passed laws or institutional capacity building), for instance, are interventions where it would be extremely challenging to define a counterfactual or even assign a single outcome variable for quantitative measurement. It would also be difficult to define accurate measurements for outcomes of projects involving campaigns to raise awareness about Climate Change or technical assistance to local authorities.

6. Recommendations

The presented evidence relates to numerous interventions in bilateral and multilateral development cooperation. Policymakers and implementers can make use of the EGM by linking the findings with their portfolio and partner preferences, to prioritize project/investment and research needs. Indeed, the identified gaps in evidence point to interventions and instruments that are lacking thorough impact assessments. Given the common aim of evidence-based policy-making in development cooperation, the gaps need to be closed to guarantee the effectiveness and impact of development cooperation. This is an important finding of this EGM.

The current evidence base on CCA suggests that efforts should be directed towards improving the evidence base in the water sector, which is one of the most important in CCA. In terms of CCA, combining impact evaluations with adoption studies is useful as even when the effectiveness of an intervention is known, the factors that aid the intervention in its adoption are an important issue. The agricultural sector contains enough studies for systematic reviews or meta-analysis to be performed, particularly in terms of adoption

studies. The dearth of evidence in the enabling environment outcome would be worth investigating further with some research into the qualitative evidence base. Lastly and across all sectors, rigorous impact evaluations are able to reveal unintended effects and maladaptation resulting from CCA interventions. Thus, the generation of further rigorous impact evaluations evidence in CCA should be prioritized.

PART II: INTERVENTION HEAT MAPS

A. Introduction

In part I of this report, we present the EGM on CCA in low- and middle-income countries. It shows which interventions are backed up by evidence regarding their effectiveness in achieving different adaptation outcomes; evidence gaps are identified. The EGM enables all stakeholders to explore the findings and quality of the existing evidence on CCA, inform policy-making, and facilitate the design and implementation of adaptation projects.

While the EGM identifies both the evidence and the gaps in the evidence base, it does not identify the financial volume or number of projects/investments implemented. In order to generate this information, we developed an IHM. An IHM is a systematic comparison of intervention portfolios undertaken by or with funds from development organisations with the available evidence in the EGM. It can give substantial insights for portfolio development and thus, should have a high priority. The comparison enables planners and decision-makers to determine if adaptation projects/investments in their portfolio are operating in evidence-scarce environments (i.e. in fields where no or little evidence is available) or if it has interventions in evidence-rich fields (i.e. in sectors with intervention types where a large body of evidence is available). These IHMs help us take traditional EGMs further since we are able to understand the extent to which resources and the evidence base are correlated in an organization.

In part II of this report, we provide a systematic presentation of the intervention portfolio of one national and one international institution in IHMs, using the framework of the EGM. Both, the German Cooperation and the GCF have large project/investment portfolios that are directed towards CCA. We evaluated the cross-section between the spread of evidence contained in the EGM and the allocation of interventions for these two institutions. We overlaid the resulting heat map of the intervention portfolios with the evidence base of the EGM for each of the intervention types/outcome cells of the framework. In the IHM, we examined both the number of projects and investments allocated to adaptation interventions of German Cooperation and GCF. We provide these results in separate heat maps of funding and the number of project/investment interventions, and separately between the institutions.[11]

B. Methods

We examined the number of project/investment interventions, the amount of commitments on adaptation for German Cooperation (2010-2017, OECD-CRS data) and funds invested by the GCF (until Oct 2019). The comparison of the project/investment portfolios of German Cooperation and GCF is based on data from a sample of 3,268 and 79 projects/investments that were classified as CCA, respectively. We coded the available data of these projects/investments and – for those which yielded sufficient information – mapped them with the intervention types and outcomes of the project, categorized into the EGM sectors/intervention types and outcomes. Most projects (1,782) from German Cooperation were coded as a single intervention type, while 386 projects from German Cooperation and 74 investments from the GCF comprised multiple intervention types. The information from these projects/investments with multiple intervention types was coded in 784 additional lines in our database, yielding a total number of 3,026 project/investment interventions categorized according to our intervention types. Annex 3 provides details on the data used and the methods for developing the intervention heat maps.

[11] Under the term “project/investment intervention” we refer to interventions within a project or investment. Each intervention potentially could be mapped to multiple intervention types and outcomes.

C. Results

Out of the 3,347 projects/investments on adaptation from both German Cooperation and the GCF, a total of 2,242 were included in the IHM. In total, 1,105 projects/investments were excluded from analysis either due to the uncertainty in the categorization, ambiguous or insufficient descriptions regarding their activities, or their irrelevance to adaptation (Table 14).

Table 14 Number of projects/investments coded for German Cooperation and the Green Climate Fund (GCF)

INCLUDE / EXCLUDE	COUNT GERMAN COOPERATION	COUNT GCF	TOTAL
Included; Coded	2,168	74	2,242
Excluded; Information unclear or incomplete; Not CCA	1,100	5	1,105
TOTAL	**3,268**	**79**	**3,347**

Table 15 shows the distribution of funded projects/investments across different regions classified by the World Bank. Latin America and Sub-Saharan Africa have received the largest number of initiatives, whereas in the opposite side of the ranking, Europe & Central Asia and North Africa & the Middle East stand as the regions with the least number of project/investment interventions.

Table 15 Number of included interventions by World Bank region

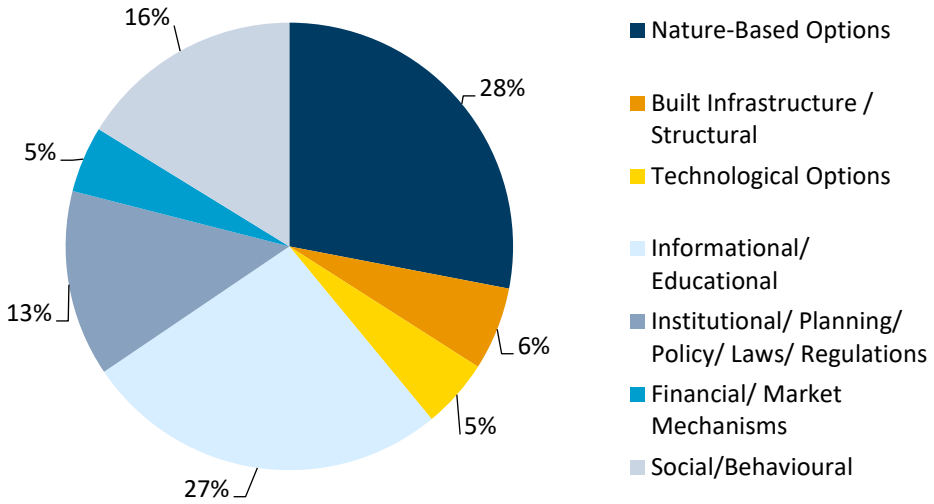
WORLD BANK REGION	GERMAN COOPERATION	GCF	TOTAL
East Asia & Pacific	282	12	294
Europe & Central Asia	56	5	61
Latin America & Caribbean	795	12	807
Middle East & North Africa	79	5	84
South Asia	227	11	238
Sub-Saharan Africa	540	26	566
Global/multi-region	189	3	192
TOTAL	**2,168**	**74**	**2,242**

We assessed these activities of the German Cooperation and GCF in terms of budgets and number of project/investment interventions. Here forth, we present the results of German Cooperation and GCF combined. For disaggregated results, including Figures and intervention heat maps, see Annex 4 for the German Cooperation and Annex 5 for the GCF.

Table 16 shows the IHM for all coded project/investment interventions funded by German Cooperation and GCF in terms of the total number. There was a total of 3,026 project/investment interventions as some projects/investments in countries contained several intervention types (see Annex 3). Consistently with the results of the EGM, the majority of project/investment interventions are found in the forestry, fishing and agriculture sector with 1,224 individual project/investment interventions (40.4 per cent), followed by society, economy and health with 827 (27.3 per cent). The water sector (WAT) constitutes 15 per cent of project/investment interventions and land use and built environment 17 per cent.

Disaggregated by intervention types (Figure 13), the most frequent categories are nature-based options (28 per cent), informational/educational (26.5 per cent) and social/behavioural (16.2 per cent). Underrepresented are financial and market mechanisms and technological options (5 per cent each), built infrastructure /structural interventions (6 per cent), institutional mechanisms (13 per cent) and social & behavioural (16 per cent).

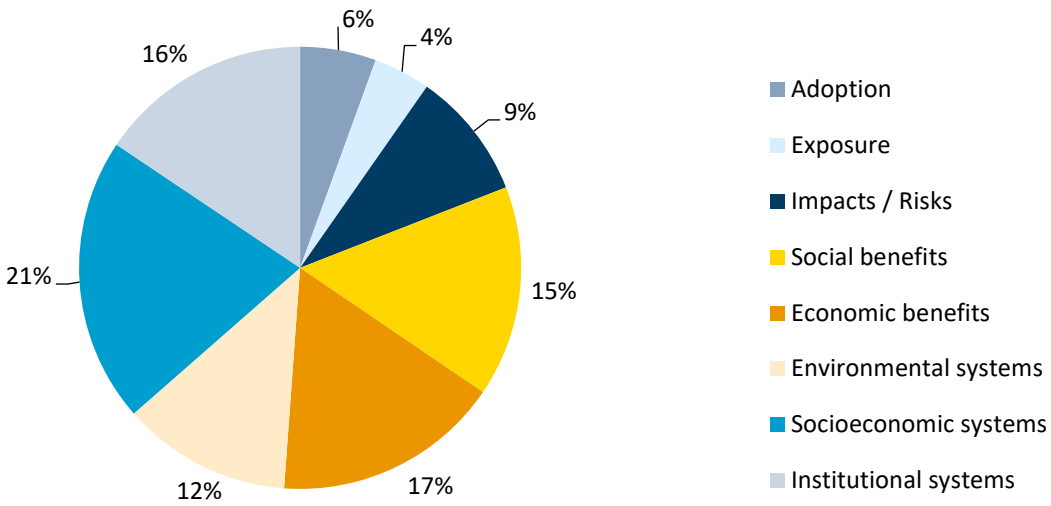
Figure 13 Distribution by intervention type in the Intervention Heat Map[12]



Source: authors` own figure

Table 16 also shows that the largest share of project/investment interventions (49 per cent) have outcomes related to the enabling environment (as summarized in Figure 14); environmental (12 per cent), socioeconomic (21 per cent) and institutional systems (16 per cent).

Figure 14 Distribution of outcomes in the Intervention Heat Map



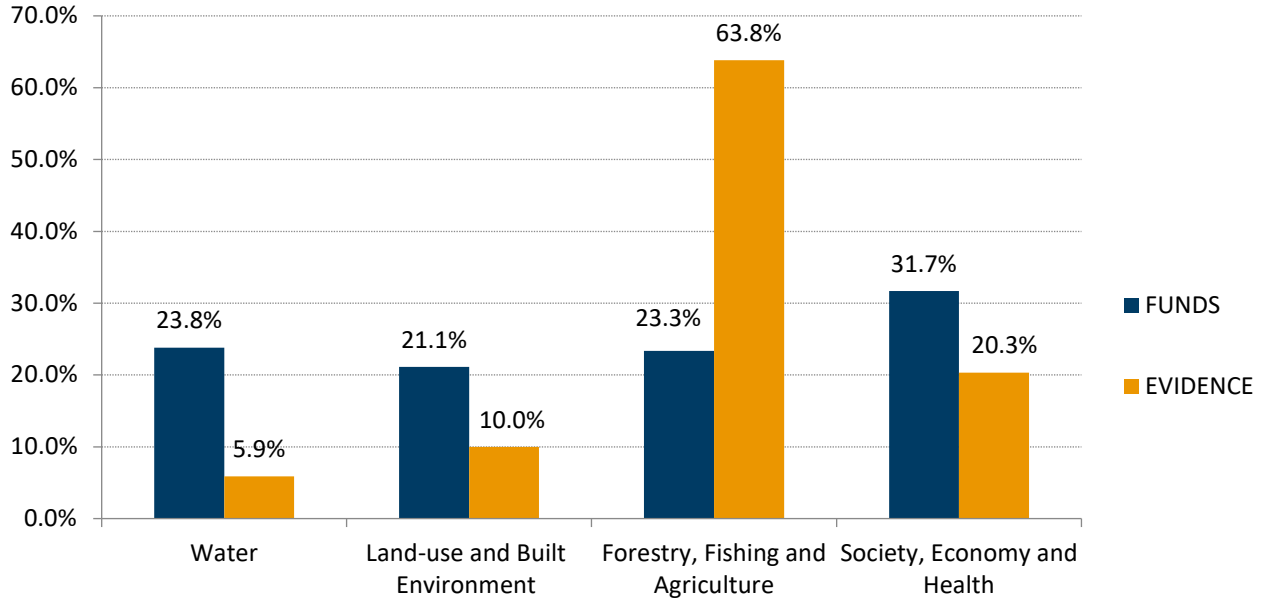
Source: authors` own figure

[12] Figures 13 to 16 are also separately displayed in Annex 4 and Annex 5 based on disaggregated data from German Cooperation and GCF, respectively.

The least number of project/investment interventions are therefore those aimed at adoption of CCA and decreasing exposure of shocks and stressors as well as project/investment interventions in the WAT and LBE sector, and in general project/investment interventions related to financial and market mechanisms and built infrastructure and structural interventions. On the other hand, there are many interventions in the FFA and SEH sectors addressing the enabling environment and adaptive capacity of people.

Table 17 shows the IHM for the budget spent on the intervention types. This shows a different pattern than in terms of the number of project/investment interventions, as funds are more evenly spread out in the sectors as a whole, with each of them accumulating about a quarter of the budget (see also Figure 15).

Figure 15 Distribution of funds and evidence for adaptation in each sector of the EGM

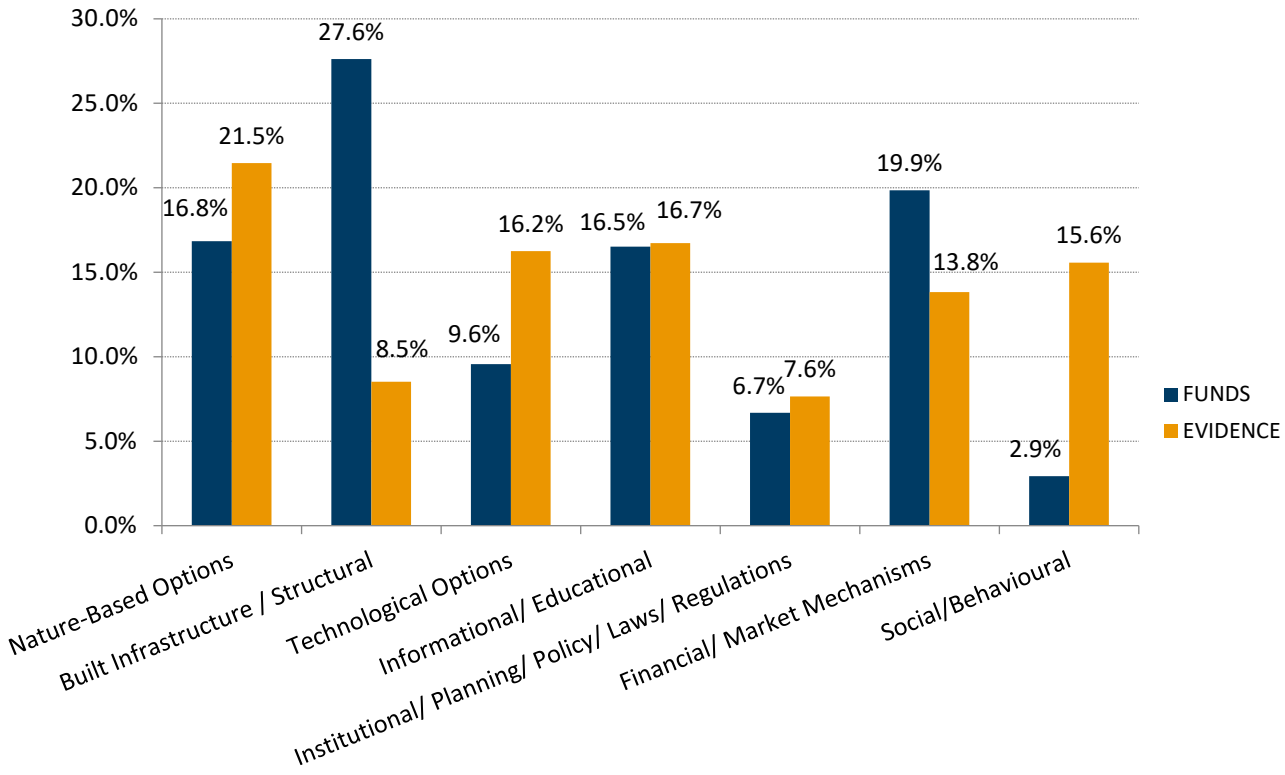


Source: authors` own figure

For the purpose of identifying possible gaps between research evidence and the actual allocation of funds in the adaptation field, Table 18 overlays the IHM with the EGM. As can be seen, there is some consistency with regard to FFA and SEH sectors: These sectors contain more evidence than the other sectors and also contain the most funded project/investment interventions (see also Figure 15). By outcomes, the number of implemented project/investment interventions are significantly higher than the number of studies with regards to the social benefits, socio-economic and institutional systems, as outcome categories. Some individual cases are worth noting for the significant imbalance between funds and evidence (greater levels of the former over the latter). These would be for instance, water infrastructure interventions as well as nature-based/technological options in connection to environmental outcomes.

In terms of intervention types, the majority of funds were spent on built infrastructure and structural project/investment interventions, while the research evidence on its effectiveness is quite limited, when comparing both distributions (Figure 16). Financial/market mechanisms and informational/educational are other intervention types that have been given large budgets, according to the data, although in these cases the evidence seems to be more aligned in relative terms. The only imbalance of the opposite side (more relative evidence than actual interventions/budget) is found in the case of social/behavioural actions.

Figure 16 Percentage distribution of funds for adaptation intervention types compared with the percentage distribution of research evidence



Source: authors` own figure

Table 16 Intervention Heat Map, combined for German Cooperation and the GCF (number of project/investment interventions)

INTERVENTION HEAT MAP		UPTAKE	SHOCKS AND STRESSOR		ADAPTIVE CAPACITY		ENABLING ENVIRONMENT		
SECTORS	INTERVENTION/OUTCOMES	Adoption	Exposure	Impacts / Risks	Social benefits	Economic benefits	Environmental systems	Socioeconomic systems	Institutional systems
Water	Nature-Based Options		31	15	25	9	33	7	12
	Built Infrastructure / Structural	4	11	33	32	26	1	4	
	Technological Options	2	2	5	10	1	1	8	
	Informational/ Educational	7	1	14	9	8	4	8	61
	Institutional/ Planning/ Policy/ Laws/ Regulations	1		2	6		12	2	26
	Financial/ Market Mechanisms	1				4			
	Social/Behavioural			6	1			14	
Land-use and Built Environment	Nature-Based Options		10	17	7	14	90	4	5
	Built Infrastructure / Structural		8	10	12	2	2	1	
	Technological Options			1		1	2		3
	Informational/ Educational	10		5	4		11	24	56
	Institutional/ Planning/ Policy/ Laws/ Regulations	22	3	3	5	60	50	19	18
	Financial/ Market Mechanisms	6				6	13	4	
	Social/ Behavioural							4	4
Forestry, Fishing and Agriculture	Nature-Based Options	4	35	23	131	164	94	69	4
	Built Infrastructure / Structural			2	6	14			
	Technological Options	2	14	3	2	41		9	
	Informational/ Educational	54		9	29	40	19	47	25
	Institutional/ Planning/ Policy/ Laws/ Regulations	1			10	5		5	19
	Financial/ Market Mechanisms	3	1	13	1	31		9	
	Social/ Behavioural		1		54	47	9	172	3
Society, Economy and Health	Nature-Based Options		1		12	4	10	18	
	Built Infrastructure / Structural			1	7			5	1
	Technological Options	5	2	16		2	1	6	12
	Informational/ Educational	29		29	47	4	5	93	150
	Institutional/ Planning/ Policy/ Laws/ Regulations	8	5	18	18	5	10	23	51
	Financial/ Market Mechanisms	9		28	3	4		4	5
	Social/ Behavioural		1	30	36	12	8	72	17

Table 17 Intervention Heat Map, combined for German Cooperation and GCF (budget, millions of USD)

INTERVENTION HEAT MAP (budget, millions of USD)		UPTAKE	SHOCKS AND STRESSOR		ADAPTIVE CAPACITY		ENABLING ENVIRONMENT		
SECTORS	INTERVENTION/OUTCOMES	Adoption	Exposure	Impacts / Risks	Social benefits	Economic benefits	Environmental systems	Socioeconomic systems	Institutional systems
Water	Nature-Based Options		35.85	13.78	4.83	2.65	31.58	0.47	9.38
	Built Infrastructure / Structural		217.49	167.90	120.40	124.14	7.89	32.79	
	Technological Options	4.82	5.75	13.61	3.17		1.42	8.25	
	Informational/ Educational	2.89	7.04	13.78	5.93	8.19	8.72	9.89	55.04
	Institutional/ Planning/ Policy/ Laws/ Regulations			4.15	19.30		0.76	0.72	27.35
	Financial/ Market Mechanisms	9.30				0.47			
	Social/Behavioural			6.74	1.73			3.77	
Land-use and Built Environment	Nature-Based Options		34.23	23.47	4.86	16.28	172.20	0.08	5.80
	Built Infrastructure / Structural		26.88	68.51	24.66	2.67	241.96		
	Technological Options			4.83		14.99	61.02		1.53
	Informational/ Educational	8.55		0.37	1.26		1.17	4.66	46.97
	Institutional/ Planning/ Policy/ Laws/ Regulations	12.75	0.74	4.99	0.03	2.17	40.64	1.07	12.33
	Financial/ Market Mechanisms	7.26				28.50	1.98	0.06	
	Social/Behavioural							0.87	0.04
Forestry, Fishing and Agriculture	Nature-Based Options	0.21	7.16	42.24	36.53	155.51	48.36	5.44	2.96
	Built Infrastructure / Structural			26.40	11.55	40.81			
	Technological Options	0.11	6.55	3.12	0.36	147.78		7.19	
	Informational/ Educational	35.08		3.49	3.95	51.93	4.24	35.38	16.75
	Institutional/ Planning/ Policy/ Laws/ Regulations	6.81			5.53	1.22		0.21	2.23
	Financial/ Market Mechanisms	41.75	2.52	79.88		93.52		1.32	
	Social/Behavioural		0.73		6.63	11.27	3.55	15.04	6.96
Society, Economy and Health	Nature-Based Options		12.60		12.00	1.84	7.38	13.51	
	Built Infrastructure / Structural			28.33	0.45			5.37	2.35
	Technological Options	0.25	9.32	32.23		19.43	1.52	19.89	31.27
	Informational/ Educational	17.73		40.03	7.79	0.69	8.90	83.18	204.28
	Institutional/ Planning/ Policy/ Laws/ Regulations	4.02	0.71	15.75	19.17	4.82	8.59	42.83	39.04
	Financial/ Market Mechanisms	231.95		305.80	10.34	12.27			0.02
	Social/Behavioural		6.42	15.64	4.93	8.77	2.78	14.15	11.99

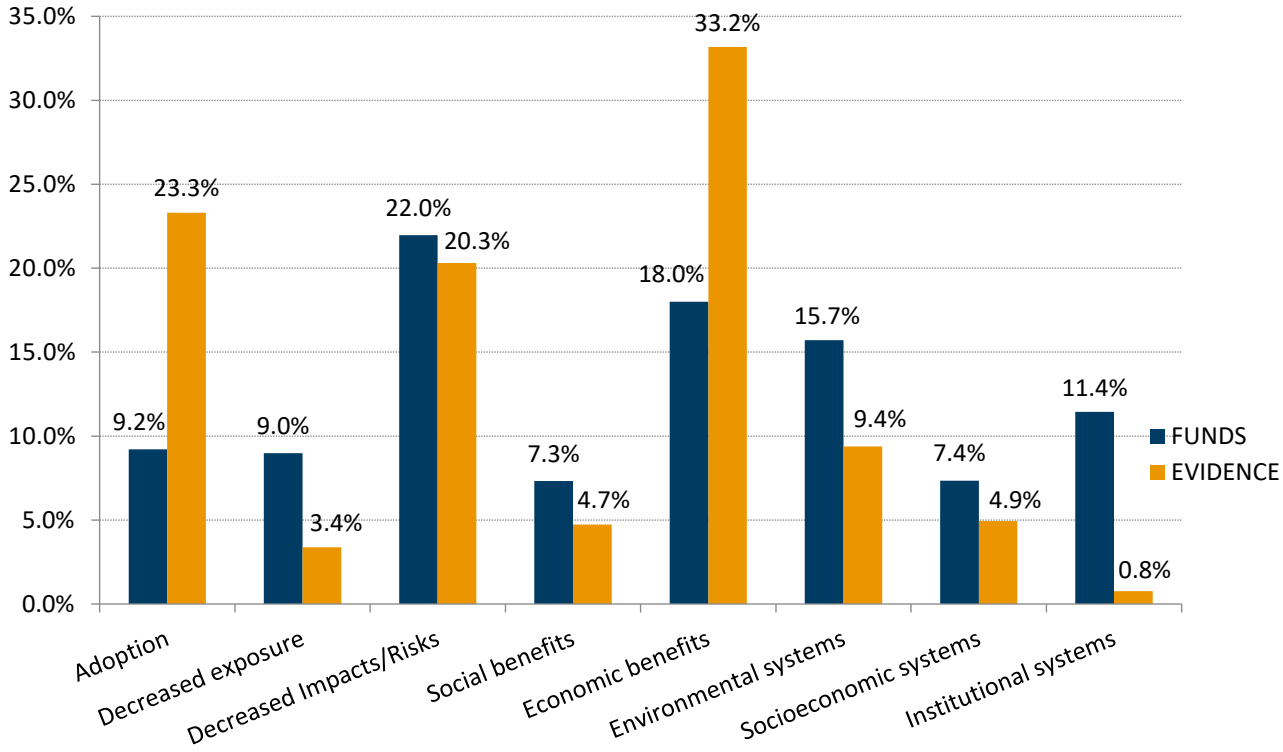
Table 18 IHM (budget, millions of USD) overlaid with the EGM, combined for German Cooperation and GCF (left: IHM in blue, right: EGM in orange)

INTERVENTION HEAT MAP (budget, millions of USD) overlayed with EVIDENCE GAP MAP		UPTAKE		SHOCKS AND STRESSOR				ADAPTIVE CAPACITY				ENABLING ENVIRONMENT					
SECTORS	INTERVENTION/OUTCOMES	Adoption		Decreased exposure		Decreased Impacts/Risks		Social benefits		Economic benefits		Environmental systems		Socioeconomic systems		Institutional systems	
	Example specific outcomes indicators	Uptake		Population affected by extreme weather events		Proactive and reactive risk management; climate related illness; deaths; food security		Skills acquired, access, awareness		Livelihood diversification, productivitiy gains, access		Area protected, ecological services improved		Social capital enhanced, overall poverty measurements		Policy changes, regulations approved, institutional reform	
Water	Nature-Based Options			35.85		13.78		4.83	1	2.65	3	31.58	3	0.47		9.38	
	Built Infrastructure / Structural		1	217.49	1	167.90	10	120.40	2	124.14	9	7.89	3	32.79	2		
	Technological Options	4.82		5.75		13.61	1	3.17			1	1.42	1	8.25			
	Informational/ Educational	2.89	2	7.04		13.78	3	5.93		8.19	1	8.72	1	9.89		55.04	
	Institutional/ Planning/ Policy/ Laws/ Regulations		1			4.15	3	19.30	1		2	0.76		0.72		27.35	
	Financial/ Market Mechanisms	9.30	1				1			0.47			2				
	Social/Behavioural		1			6.74	1	1.73	1		1		1	3.77			
Land-use and Built Environment	Nature-Based Options		1	34.23	14	23.47	4	4.86	1	16.28	3	172.20	2	0.08	1	5.80	
	Built Infrastructure / Structural		3	26.88	4	68.51	4	24.66		2.67	5	241.96	3		1		
	Technological Options					4.83	1			14.99		61.02	3			1.53	
	Informational/ Educational	8.55	3			0.37	4	1.26	1			1.17	3	4.66		46.97	
	Institutional/ Planning/ Policy/ Laws/ Regulations	12.75	2	0.74	3	4.99	2	0.03	1	2.17	4	40.64	4	1.07	2	12.33	2
	Financial/ Market Mechanisms	7.26	2				2		1	28.50		1.98	2	0.06			
	Social/Behavioural		1		1		5		3		2		2	0.87	1	0.04	
Forestry, Fishing and Agriculture	Nature-Based Options	0.21	3	7.16	2	42.24	29	36.53	2	155.51	106	48.36	34	5.44	8	2.96	
	Built Infrastructure / Structural		11			26.40	5	11.55	1	40.81	9		1				
	Technological Options	0.11	7	6.55	2	3.12	19	0.36	2	147.78	100		17	7.19	5		
	Informational/ Educational	35.08	77		1	3.49	7	3.95	9	51.93	19	4.24	5	35.38	5	16.75	
	Institutional/ Planning/ Policy/ Laws/ Regulations	6.81	14				3	5.53	1	1.22	5			0.21	3	2.23	
	Financial/ Market Mechanisms	41.75	44	2.52	1	79.88	6		4	93.52	14		4	1.32	5		
	Social/Behavioural		36	0.73			5	6.63	3	11.27	19	3.55	4	15.04	3	6.96	
Society, Economy and Health	Nature-Based Options		1	12.60			3	12.00	1	1.84		7.38		13.51			
	Built Infrastructure / Structural		1			28.33	9	0.45			3			5.37		2.35	
	Technological Options	0.25		9.32		32.23	8			19.43		1.52		19.89	1	31.27	
	Informational/ Educational	17.73	9		2	40.03	10	7.79	8	0.69	2	8.90		83.18	1	204.28	
	Institutional/ Planning/ Policy/ Laws/ Regulations	4.02	2	0.71	1	15.75	15	19.17		4.82	4	8.59		42.83	2	39.04	2
	Financial/ Market Mechanisms	231.95	5		1	305.80	26	10.34	1	12.27	14		1		5	0.02	1
	Social/Behavioural		13	6.42	2	15.64	24	4.93	5	8.77	17	2.78	1	14.15	6	11.99	3

Note: Table 18 shows the IHM based on aggregated data from German Cooperation and GCF. For intervention heat maps based on disaggregated data, see Annex 4 for German Cooperation and Annex 5 for the GCF. For both institutions, we display the IHMs separately for the number of project/investment interventions and the budget (millions of USD).

In terms of outcomes, the reduction of risks accumulated the largest proportion of funds, followed by economic benefits and environmental systems (Figure 17). The funding towards the outcomes matches relatively well with the evidence, aside from those pertaining to institutional systems and decreased exposure. A relatively high proportion of evidence is found in outcomes towards economic benefits and adoption.

Figure 17 Percentage distribution of funds for adaptation outcomes compared with the evidence



Source: authors` own figure

D. Discussion and Implications

The IHM offers a visual representation of how the CCA projects/investments by German Cooperation and GCF are distributed among the different sectors, intervention types and outcomes defined in the EGM framework. The combination of the EGM and intervention heat map is ideally an indispensable source for policymakers to explore the findings and quality of the existing evidence. It allows them to see if they are operating in evidence-rich or evidence-scarce environments and prioritize the generation of new evidence for CCA. However, some specificities of the interventions and evidence need to be considered to interpret these results.

The EGM only considers rigorous evidence, those that use quantitative data or use experimental methods, which might explain some observed imbalances between the flow of funds and the availability of research and evaluations. Thus, as stated in part I, some interventions are not entirely suitable for the kind of impact assessments that fulfilled the inclusion criteria of the EGM. Built infrastructure and structural interventions, newly built or renewed infrastructure, as well as many governance related actions (e.g. passed laws or institutional capacity building), for instance, are interventions where it would be challenging to define a counterfactual or even assign a single outcome variable for quantitative measurement. Furthermore, sectors such as WAT with infrastructure projects are frequently evidenced by modelling studies. However, such studies cannot replace actual impact evaluations to demonstrate effectiveness and developmental impacts. For example, once infrastructure interventions are completed and functional, the target population may not be targeted as predicted in the modelling and the actual use may differ from the projected use. Long-term and developmental impacts cannot necessarily be accurately assumed from modelling studies.

Generally, it may also be difficult to define accurate measurements for outcomes of interventions involving campaigns to raise awareness about climate change or technical assistance to local authorities. This could explain the weight of financial flows in four sectors, i.e. “Informational/Educational” intervention types which promote an enabling environment in both socioeconomic and institutional systems. These project/investment interventions are relatively abundant, although there is close to no evidence regarding their effectiveness.

When considering the funds allocated to each cell in the EGM framework, it must be noted that the budget differs drastically between intervention types. For instance, the construction of new irrigation infrastructure will typically require more funding than a project providing extension services through a local farmer’s association. Thus, it is to be expected that the “Built infrastructure/ Structural” intervention type has a higher share when the allocation of funds is considered. Therefore, an analysis between funds and evidence does not carry a linear relationship.

CONCLUSION AND OUTLOOK

The EGM on CCA takes stock of the high-quality evidence related to the interventions and outcomes of adaptation in low to middle income countries. It provides a valuable resource for policymakers and researchers not only by identifying gaps where further impact assessments need to be prioritized, but also by highlighting areas where there is a large body evidence base. This can support evidence-based decision-making in the design and implementation of future adaptation interventions. Meta-analyses and in-depth reviews on the sources used for the evidence base can be carried out to answer specific questions. Such further studies are necessary to retrieve more detailed and relevant information such as determinants and effect sizes from the evidence base, in order to better inform the programming and planning of projects/investments. Besides supporting the prioritization of generating new evidence, the EGM can subsequently and regularly be updated to capture this newly generated evidence. Since EGMs help prioritize the generation of new evidence, it is important to consider the evidence base as not static but growing. Thus, EGMs require regular updating. The systematic methodology of the EGM allows replicating the approach to capture this newly generated evidence.

Specifically, the EGM on CCA

- provides a robust typology of four sectors[13], seven intervention types[14] and four outcome groups[15] that serves as a conceptual tool for defining the objectives of further studies and for better locating interventions;
- provides an accessible overview of evidence from systematic reviews and impact evaluations;
- highlights available evidence and its characteristics, such as confidence ratings of systematic reviews;
- allows users to explore the evidence base and findings of relevant studies;
- reflects relevant interventions and outcomes associated with a particular area, and are structured around a framework (matrix);
- populates areas with available studies and reviews, while highlighting “absolute gaps” related to impact evaluations and systematic reviews; and
- highlights “synthesis gaps” and especially where there is a concentration of impact evaluations but no recent high-quality systematic review.

The EGM covers the global evidence on the effectiveness of CCA interventions. Thus, we can derive global conclusions from it. Compared to the scope of the EGM, the perspective of the IHM analysis is based on the aggregated portfolios of German Cooperation and GCF, thus providing conclusions only for the two institutions.

Overlaying the IHM with the EGM:

- provides a systematic comparison of the project/investment portfolios with the available evidence;
- can give substantial insights for portfolio development;
- enables planners and decision makers to see whether the adaptation projects/investments in their portfolio are operating in evidence-rich or evidence-scarce fields;

[13] Sectors: 1) Water; 2) Forestry, Fisheries and Agriculture; 3) Land use and Built Environment; and 4) Society, Economy and Health.

[14] Intervention types: 1) Nature-Based Options; 2) Built Infrastructure / Structural; 3) Technological Options; 4) Informational/ Educational; 5) Institutional/ Planning/ Policy/ Laws/ Regulations; 6) Financial/ Market Mechanisms; and 7) Social/Behavioural.

[15] Outcome groups: 1) Uptake; 2) Shocks and stressors; 3) Adaptive capacity; and 4) Enabling environment

- is a tool to prioritize the generation of new evidence for CCA: either to generate new evidence through more rigorous impact evaluations (in fields where no or little evidence is available) or to synthesize existing evidence by carrying out meta-analyses or in-depth reviews in order to increase the usability of the evidence for planners, decision-makers and implementers;
- helps to understand the extent to which resources and evidence base are related in an organization to aid portfolio development;
- helps to systematically expand the global evidence base on CCA interventions in order to facilitate future evidence-based programming and portfolio development.

Therefore, the overlay of IHM with the EGM provides important information for planners and policymakers. However, it should be noted that EGMs cover mainly rigorous impact evaluations and systematic reviews and typically exclude qualitative evidence. This EGM extended the scope by also including non-experimental quantitative studies due to the limited use of counterfactual-based analyses in CCA. Furthermore, to be able to draw wider conclusions that can be used by other institutions, further IHMs are necessary that incorporate their portfolios.

Results from the 464 included studies in the EGM indicate large variations in CCA evidence by region, sector, intervention type and outcome. Evidence catalogued on adaptation actions is concentrated in Sub-Saharan Africa, South Asia and East Asia & Pacific. Evidence gaps are in Latin America & Caribbean, Middle East & North Africa, and Central Asia. Most of the evidence is concentrated in the forestry, fisheries, and agriculture sector; the second most populated sector of the EGM is society, economy and health. The largest evidence gaps are the water sector and in land use and built environment. Nature-based solutions are the most studied intervention type, while interventions related to policy and infrastructure are the least studied.

The IHM shows that in the aggregated GCF and German Cooperation portfolios,[16] the fewest project/investment interventions are those:

- that target the outcomes *adoption of CCA* and *decreasing exposure of shocks and stressors*,
- that are in the *WAT* and *LBE* sectors,
- that relate to the intervention types of *financial and market mechanisms*, and *built infrastructure and structural interventions*.

Compared to the evidence from the EGM, while there is a wealth of information on adoption and some on financial mechanism, these aforementioned gaps are also gaps in evidence. The IHM also shows that the FFA and SEH sectors are a substantial part of the GCF and German Cooperation CCA portfolios and target outcomes related to adaptive capacity and the enabling environment. These sectors and their outcomes on adaptive capacity have been well documented in the literature as the EGM found. However, less so for outcomes related to the enabling environment. In contrast, the allocation of funding matches perhaps more the expense of each intervention type rather than necessarily the evidence.

The current evidence base on CCA suggests that efforts should be directed towards improving the evidence base in the water sector, which is one of the most important in CCA, although this is also an area that has the least project/investment interventions in the portfolios examined, yet has allocated a quarter of funds.

Finally, given that the aggregated CCA portfolios of the German Cooperation and the GCF examined aim in majority at outcomes within the enabling environment, it provides an opportunity to improve the evidence concerning these outcomes by applying more rigorous evaluations. It would also be the case for other areas where projects/investments are allocated but evidence is lacking.

[16] For figures and intervention heat maps based on disaggregated data, see Annex 4 for German Cooperation and Annex 5 for GCF.

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ANNEXES

Annex 1. Search

Publication database searches

- Web of Science
- Scopus
- Environmental Evidence Library
- 3ie database

The field codes “Topic (TS)” and “Abstract (ABS)” were used for WoS and Scopus, respectively. A title exclusion (TI) was also included for biological terms instead of making exclusions based on journal or category, because trialling this we found that we missed potentially useful evidence.

Specialist searches

A selection of “grey” literature was identified by going directly to relevant organization websites, informed by the list of relevant sources determined by expert input. These included:

- Inter-American Development Bank: *https://www.iadb.org/en*
- IDEAS–Repec: *https://ideas.repec.org/*
- World Bank–Open Knowledge Repository: *https://openknowledge.worldbank.org/*
- Ecologic Institute EU (Ecologic): *https://www.ecologic.eu/*
- Research for Development: *www.r4d.ch/*
- Building Resilience and Adaptation to climate extremes and disasters: *http://www.braced.org*
- Mercy Corps: *https://www.mercycorps.org.uk*
- Resilience, Evaluation, Analysis and Learning (REAL): *https://www.fsnnetwork.org/REAL*
- Earth–Eval: *https://www.climate-eval.org/eLibrary*
- DFID research output: *https://www.gov.uk/dfid-research-outputs*

Search strategy

Grey literature: The search terms “climate change adaptation” and “impact evaluation” were used.

Web of Science and Scopus search:

TS= ("climat* change" OR "global warming" OR "climat* variability" OR "climat* hazard" OR “weather variability” OR “sea-level*” OR “sea level” OR “extreme event*” OR “heat wave*” OR "extreme weather" OR "natural hazard" OR (climate AND fire) OR flood* OR drought OR hurricane OR storm OR cyclone OR mudslide* OR landslide* OR "rainfall variability" OR “natural disaster*” OR “precipitation variability” OR “temperature variability”)

AND TS= (“empirical evidence” OR empiric* OR "impact evaluation" OR "systematic review" OR “statistical analysis” OR counterfactual OR experiment* OR "quasi-experimental" OR “discontinuity design” OR "discontinuity regression" OR "regression discontinuity" OR “fixed effect*” OR regression OR “difference* in difference*” OR “double differenc*” OR “instrumental variable*” OR "propensity score" OR matching OR “propensity weight*” OR “time-series” OR "panel data" OR "double robust" OR random* OR "control group" OR "pipeline approach" OR "pipeline method" OR "pipeline comparison" OR “impact assessment” OR “econometric analys*” OR “cross-sectional data” OR “difference-in-difference”)

AND TS= (household* OR farm* OR communit* OR village* OR district* OR parish* OR cooperative* OR city OR cities OR town* OR school* OR women OR children OR company OR companies OR factory OR factories OR building* OR infrastructur* OR municipalit* OR smallholder*)

AND TS= (“adapt* to” “climate change adaptation” OR “adapt* to climat*” OR “adaptive capacity” OR “adapt* strateg*” OR “adapt* intervention*” OR vulnerab* OR resilie* OR “coping with climat*” OR “coping with weather” OR “cope with climat*” OR “cope with weather” OR “coping with extreme” OR “cope with extreme” OR “disaster risk reduction” OR (disaster AND reduction) OR (climate OR risk AND mitigation) OR "risk management" OR preparedness OR “livelihood diversification” OR “early warning” OR “risk reduction” OR “reduc* risk*” OR “ecosystem-based” OR “nature-based”)

AND TS= (agricultur* OR forest* OR water* OR land* OR societ* OR social OR health OR industr* OR energ* OR fish* OR *econom* OR livelihood OR income OR develop* OR sustainab*)

NOT TS= (US OR USA OR “United States” OR “North America*” OR Alabama OR Alaska OR Arizona OR Arkansas OR California OR Colorado OR Connecticut OR Delaware OR Florida OR Hawaii OR Idaho OR Illinois OR Indiana OR Iowa OR Kansas OR Kentucky OR Louisiana OR Maine OR Maryland OR Massachusetts OR Michigan OR Minnesota OR Mississippi OR Missouri OR Montana OR Nebraska OR Nevada OR “New Hampshire” OR “New Jersey” OR “New Mexico” OR “New York” OR “North Carolina” OR “North Dakota” Ohio OR Oklahoma OR Oregon OR Pennsylvania OR “Rhode Island” OR “South Carolina” “South Dakota” OR Tennesse OR Texas Utah OR Vermont OR Virginia OR Washington OR “West Virginia” OR Wisconsin OR Wyoming OR Canad* OR UK OR England OR Scotland OR Wales OR Ireland OR Irish OR Spain OR France OR Greece OR Ital* OR Portug* OR German* OR Switzerland OR Swiss OR “New Zeal*” OR Australia* OR Israel* OR Belgi* OR Netherland* OR “Dutch” OR Luxemb* OR Denmark OR Norway OR Sweden OR Finland OR Iceland* OR Poland OR Austria* OR Malta OR Hungar* OR Czech OR Slovak* OR Latvia OR Lithuania OR Estonia OR Russia* OR Romania* OR Bulgaria* OR Serbia OR Croatia OR Japan* OR Korea* OR “Hong Kong” OR Singapore OR Saudi Arabia OR Qatar OR Emirates)

NOT TI= (Specie* OR bacteria* OR predator* OR invertebrat* OR fungal OR microbi* OR mollusc* OR phenolog* OR phenoti* OR perennial OR coral OR *plankton OR physiology OR *trophic OR biotic OR “plant” OR sediment* OR ontogenetic* OR neutropic* OR reproductive OR canop* OR inmun* OR simulati* OR predict* OR physiolog*)

Annex 2 Coding

DATA FIELD	CODE
World Bank region	
East Asia & Pacific	1
Europe & Central Asia	2
Latin America & Caribbean	3
Middle East & North Africa	4
South Asia	5
Sub-Saharan Africa	6
North America	7
Global/multi-region	0
Population	
Village/town/district/municipality/building	1
Individuals/households	2
Communities/groups	3
Institutions/companies	4
Economic units across time	5
Land plots	6
Countries	7
Study design	
Experimental	
Quasi-experimental	2
Non-experimental	3
Systematic review	4

DATA FIELD	CODE
Outcome	
Uptake	1
Shocks and stressors	2
Adaptive capacity	3
Enabling environment	4
Subcategory outcome	
Adoption	1
Decreased exposure	2
Decreased impacts/risks	3
Social benefits	4
Economic benefits	5
Environmental systems	6
Socioeconomic systems	7
Institutional systems	8

DATA FIELD	CODE
Sector	
Water	1
Built environment/land use	2
Forestry, agriculture, fishing	3
Health, economy, society	4
Intervention type	
Nature-based options	1
Built infrastructure/structural	2
Technological options	3
Informational/educational	4
Institutional/planning/policy/laws /regulations	5
Financial/market mechanisms	6
Social/behavioural	7

Annex 3. Data and Methods for Intervention Heat Maps

1. Data Sources

Our IHMs use the same framework as the EGM but plot the amount of projects/investments going towards different intervention types and outcomes. In this study, we examine the number of projects/investments and amount of funds committed on adaptation using data from the GCF and German Cooperation.

The GCF is the largest climate change fund for climate change projects. As of October 2019, the GCF had invested USD 5.3 billion in climate change. Of this, the GCF invests almost 60 per cent on so-called cross-cutting projects. More than 75 per cent of this budget finances adaptation interventions, both in adaptation and cross-cutting. Its current portfolio includes 79 projects, of which 29 are cross-cutting while the remaining 50 projects are focused on adaptation. Of these cross-cutting projects, five were identified during our codification process as mostly mitigation projects in the industry and energy sectors, and while there were some adaptation elements, they did not contain intervention types that were part of the EGM and so were excluded from the heat map. We included the remaining 74 cross-cutting and adaptation projects.

Germany's official development assistance for CDA is administered by the German Federal Ministry for Economic Cooperation and Development and – to a lesser extent – by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the German Federal Foreign Office, the German Federal Ministry of Education and Research, and the federal states of Germany. CCA projects are mainly implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit and the Kreditanstalt für Wiederaufbau Development Bank, which are responsible for Germany's technical and financial cooperation, respectively. Other relevant stakeholders are civil society organizations, research institutions and the private sector. The projects by German Cooperation can be broadly categorized into projects/programmes and funds/grants. It is important to note that German Cooperation funding is predominantly channelled through bilateral cooperation and some multilateral institutions. For example, Germany also contributes to the GCF. The IHM encompasses all of German Cooperation's bilateral CCA projects and financing from 2010 to 2017 that are identified through the OECD common reporting standard as having a "principal objective" (score "2") of adaptation (3268 interventions).

2. Data Coding

Each intervention from the database was analysed in order to identify the project/investment interventions and outcomes of the project, categorized into the EGM sectors/intervention types and outcomes (see Table 8 in part I). In most cases the brief description provided as a project summary served as the main sources of information to identify all relevant elements.

Additionally, the World Bank region and the target population (i.e. whether the projects are aimed at individuals, private organizations, local or regional governments, etc.) were recorded for each project/investment. In some cases, the available documentation did not offer enough information to code a project/investment: These were cases where intervention outcomes were not obvious, or that details on the contents and extent of the project/investment interventions were lacking. Efforts were made to gather more information from online sources and from the project documents, when they were available. For GCF investments, the main source of information was the "Approved Funding Proposal" available in the documentation section of the website profile of each project. For primary and secondary areas, we used the distribution from the budget in the Approved Funding Proposal, distributing the administrative costs proportionally.

For German Cooperation projects/investments, while the main source was the common reporting standard, when there was a lack of information, online searches in the GIZ project's database offered additional clarifications.

Projects/investments were categorized into three types:

- A: Projects/investments were coded with certainty or high level of certainty regarding intervention types/outcome categories.
- B: Projects/investments were initially coded but with significant level of uncertainty regarding intervention types/outcome categories, and therefore were eventually excluded.
- C: Projects/investments were not coded due to incomplete information, or did not relate to CCA, and therefore were excluded.

Of the 3,268 projects /investments for German Cooperation, not all had high levels of information. The number of coded projects/investments (A) from German Cooperation were 2,168. The team excluded C projects/investments. Projects /investments marked as (B) did receive some codes in the preliminary steps. However, they were subsequently excluded from the IHM (778 in number) due to uncertainty concerning the actual content of the project/investment, and their implemented project/investment interventions were judged to be high.

Most projects /investments (1,782) from German Cooperation were coded as a single intervention type, while 386 projects /investments from German Cooperation and 74 from the GCF comprised multiple intervention types. The information from these projects /investments with multiple intervention types was coded as 784 additional lines in our database, yielding a total number of 3,026 individual project /investment interventions.

Number of project/investment interventions coded for German Cooperation and the GCF

	INCLUDE / EXCLUDE	COUNT GERMAN COOPERATION	COUNT GCF	TOTAL
A	Coded	2,753	273	**3,026**
B	Coded but information unclear or incomplete	778	0	**778**
C	Excluded; Not CCA; Not enough information	322	11	**333**
	TOTAL	**3,853**	**284**	**4,137**

Out of the 4,137 project/investment interventions on adaptation from both German Cooperation and GCF, a total of 3,026 project/investment interventions were included in the IHM (categorized as type A). An additional 778 were coded, but finally excluded due to uncertainty in the categorization or the ambiguous descriptions regarding their activities.

The EGM was populated with the number of project/investment interventions and funds corresponding to "A" type projects/investments in each intervention type/outcome cell. It should be noted that a project/investment may be found into several cells in the EGM if it contains different intervention types and/or outcomes.

Annex 4. Intervention Heat Maps for German Cooperation

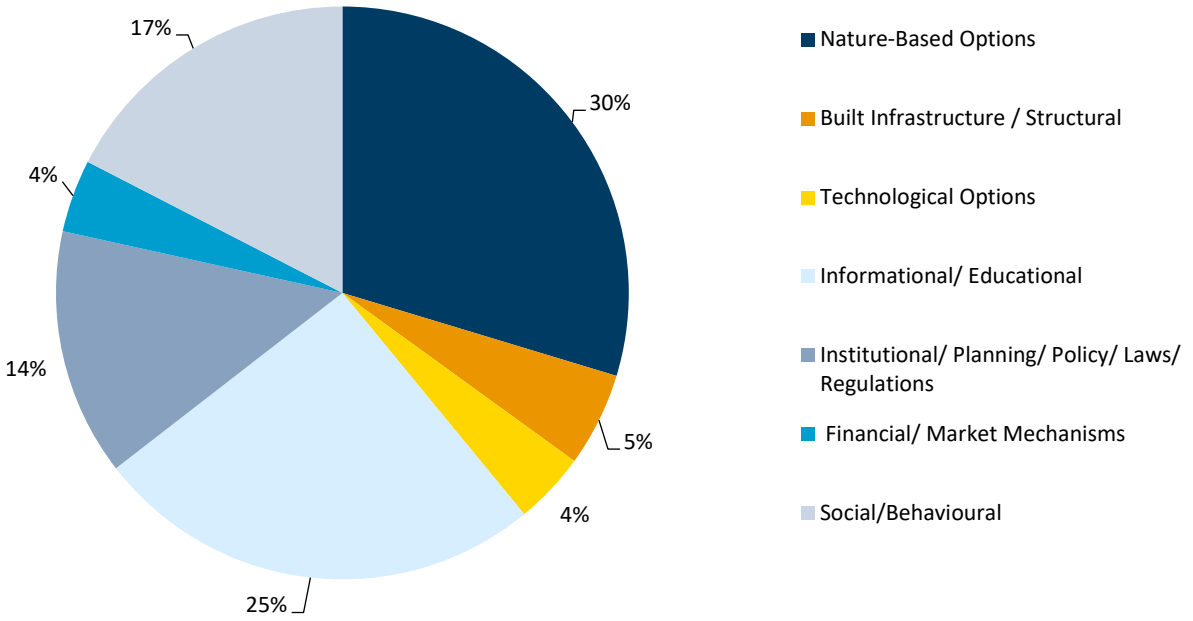
IHM of German Cooperation (number of project/investment interventions) overlaid with the EGM (left: IHM in blue, right: EGM in orange)

INTERVENTION HEAT MAP (number of project/investment interventions) overlayed with EVIDENCE GAP MAP		UPTAKE		SHOCKS AND STRESSOR				ADAPTIVE CAPACITY				ENABLING ENVIRONMENT					
SECTORS	INTERVENTION/OUTCOMES	Adoption		Decreased exposure		Decreased Impacts/Risks		Social benefits		Economic benefits		Environmental systems		Socioeconomic systems		Institutional systems	
	Example specific outcomes indicators	Uptake		Population affected by extreme weather events		Proactive and reactive risk management; climate related illness; deaths; food security		Skills acquired, access, awareness		Livelihood diversification, productivitiy gains, access		Area protected, ecological services improved		Social capital enhanced, overall poverty measurements		Policy changes, regulations approved, institutional reform	
Water	Nature-Based Options			28		15		25	1	9	3	32	3	7		12	
	Built Infrastructure / Structural	4	1	4	1	27	10	29	2	24	9	1	3	2	2		
	Technological Options	2				3	1	10		1	1		1	7			
	Informational/ Educational	5	2			12	3	9		7	1	4	1	5		52	
	Institutional/ Planning/ Policy/ Laws/ Regulations		1			1	3	6	1		2	10		2		24	
	Financial/ Market Mechanisms		1				1			4			2				
	Social/Behavioural		1			6	1		1		1		1	13			
Land-use and Built Environment	Nature-Based Options		1	6	14	16	4	7	1	14	3	81	2	4	1	5	
	Built Infrastructure / Structural		3	6	4	7	4	12			5		3	1	1		
	Technological Options					1	1					1	3			2	
	Informational/ Educational	7	3			5	4	4	1			11	3	22		50	
	Institutional/ Planning/ Policy/ Laws/ Regulations	20	2	3	3	2	2	5	1	60	4	47	4	19	2	17	2
	Financial/ Market Mechanisms	5	2				2		1			13	2	4			
	Social/Behavioural		1		1		5		3		2		2	3	1	4	
Forestry, Fishing and Agriculture	Nature-Based Options	4	3	34	2	22	29	131	2	158	106	90	34	68	8	4	
	Built Infrastructure / Structural		11				5	6	1	12	9		1				
	Technological Options	2	7	14	2		19	2	2	34	100		17	8	5		
	Informational/ Educational	51	77		1	8	7	29	9	32	19	19	5	38	5	22	
	Institutional/ Planning/ Policy/ Laws/ Regulations		14				3	10	1	3	5			5	3	18	
	Financial/ Market Mechanisms	1	44	1	1	11	6	1	4	21	14		4	9	5		
	Social/Behavioural		36	1			5	54	3	46	19	9	4	170	3	3	
Society, Economy and Health	Nature-Based Options		1	1			3	12	1	4		10		18			
	Built Infrastructure / Structural		1				9	7			3			4			
	Technological Options	5				10	8			1				1	1	8	
	Informational/ Educational	26	9		2	27	10	47	8	3	2	5		77	1	124	
	Institutional/ Planning/ Policy/ Laws/ Regulations	8	2	5	1	17	15	18		5	4	10		20	2	49	2
	Financial/ Market Mechanisms	2	5		1	28	26	3	1	1	14		1	4	5	5	1
	Social/Behavioural		13	1	2	30	24	36	5	11	17	8	1	70	6	15	3

IHM of German Cooperation (budget, millions of USD) overlaid with the EGM (left: IHM in blue, right: EGM in orange)

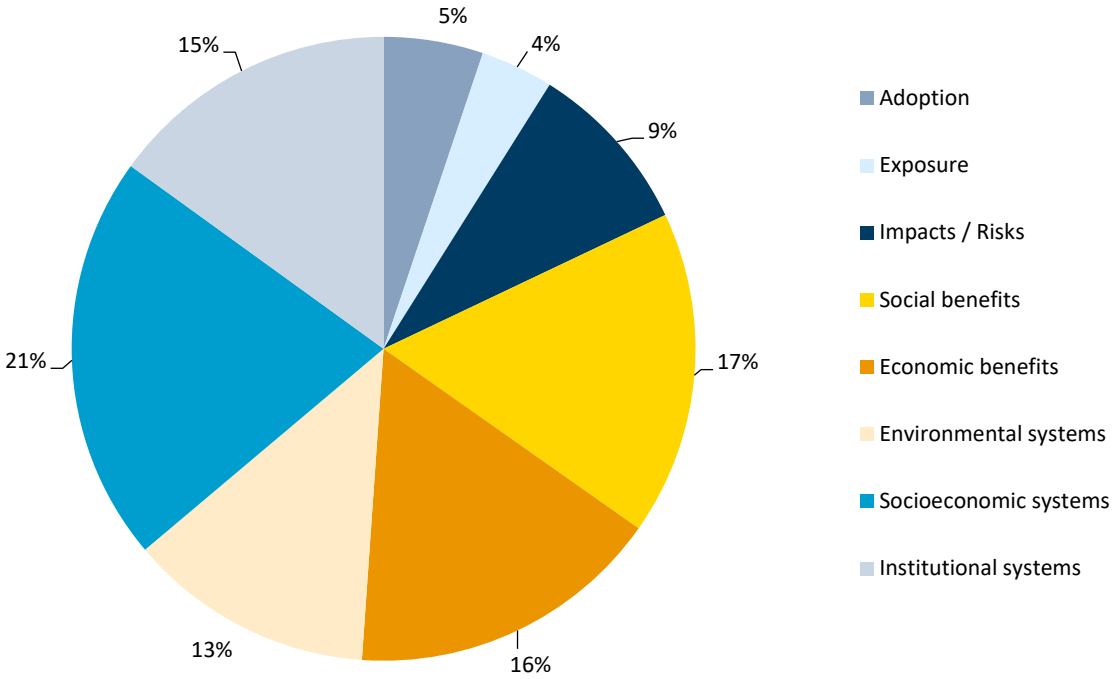
INTERVENTION HEAT MAP (budget, millions of USD) overlayed with EVIDENCE GAP MAP		UPTAKE		SHOCKS AND STRESSOR				ADAPTIVE CAPACITY				ENABLING ENVIRONMENT					
	INTERVENTION/OUTCOMES	Adoption		Decreased exposure		Decreased Impacts/Risks		Social benefits		Economic benefits		Environmental systems		Socioeconomic systems		Institutional systems	
SECTORS	Example specific outcomes indicators	Uptake		Population affected by extreme weather events		Proactive and reactive risk management; climate related illness; deaths; food security		Skills acquired, access, awareness		Livelihood diversification, productivitiy gains, access		Area protected, ecological services improved		Social capital enhanced, overall poverty measurements		Policy changes, regulations approved, institutional reform	
Water	Nature-Based Options			11.17		13.78		4.83	1	2.65	3	20.41	3	0.47		9.38	
	Built Infrastructure / Structural		1	0.11	1	32.45	10	42.88	2	79.50	9	7.89	3		2		
	Technological Options	4.82				6.87	1	3.17			1		1	0.42			
	Informational/ Educational	0.01	2			5.83	3	5.93		4.90	1	8.72	1	0.42		33.36	
	Institutional/ Planning/ Policy/ Laws/ Regulations		1				3	19.30	1		2	0.53		0.72		22.81	
	Financial/ Market Mechanisms		1				1			0.47			2				
	Social/Behavioural		1			6.74	1		1		1		1	2.25			
Land-use and Built Environment	Nature-Based Options		1	12.59	14	18.68	4	4.86	1	16.28	3	56.79	2	0.08	1	5.80	
	Built Infrastructure / Structural		3	1.27	4	2.15	4	24.66			5		3		1		
	Technological Options					4.83	1					1.96	3			0.02	
	Informational/ Educational	4.93	3			0.37	4	1.26	1			1.17	3	2.07		26.28	
	Institutional/ Planning/ Policy/ Laws/ Regulations	7.79	2	0.74	3		2	0.03	1	2.17	4	34.90	4	1.07	2	7.27	2
	Financial/ Market Mechanisms	0.96	2				2		1			1.98	2	0.06			
	Social/Behavioural		1		1		5		3		2		2	0.22	1	0.04	
Forestry, Fishing and Agriculture	Nature-Based Options	0.21	3	3.65	2	35.71	29	36.53	2	89.60	106	14.97	34	3.86	8	2.96	
	Built Infrastructure / Structural		11				5	11.55	1	5.79	9		1				
	Technological Options	0.11	7	6.55	2		19	0.36	2	98.49	100		17	6.02	5		
	Informational/ Educational	7.77	77		1	0.87	7	3.95	9	6.57	19	4.24	5	1.96	5	10.60	
	Institutional/ Planning/ Policy/ Laws/ Regulations		14				3	5.53	1	0.22	5			0.21	3	1.35	
	Financial/ Market Mechanisms	3.71	44	2.52	1	72.35	6		4	15.73	14		4	1.32	5		
	Social/Behavioural		36	0.73			5	6.63	3	3.50	19	3.55	4	12.58	3	6.96	
Society, Economy and Health	Nature-Based Options		1	12.60			3	12.00	1	1.84		7.38		13.51			
	Built Infrastructure / Structural		1				9	0.45			3			0.31			
	Technological Options	0.25				4.44	8			0.04				2.82	1	11.51	
	Informational/ Educational	8.98	9		2	9.54	10	7.79	8	0.08	2	8.90		20.47	1	71.64	
	Institutional/ Planning/ Policy/ Laws/ Regulations	4.02	2	0.71	1	13.30	15	19.17		4.82	4	8.59		26.11	2	38.02	2
	Financial/ Market Mechanisms		5		1	305.80	26	10.34	1	0.05	14		1		5	0.02	1
	Social/Behavioural		13	6.42	2	15.64	24	4.93	5	2.84	17	2.78	1	6.54	6	7.88	3

Distribution by intervention type in the Intervention Heat Map (German Cooperation)



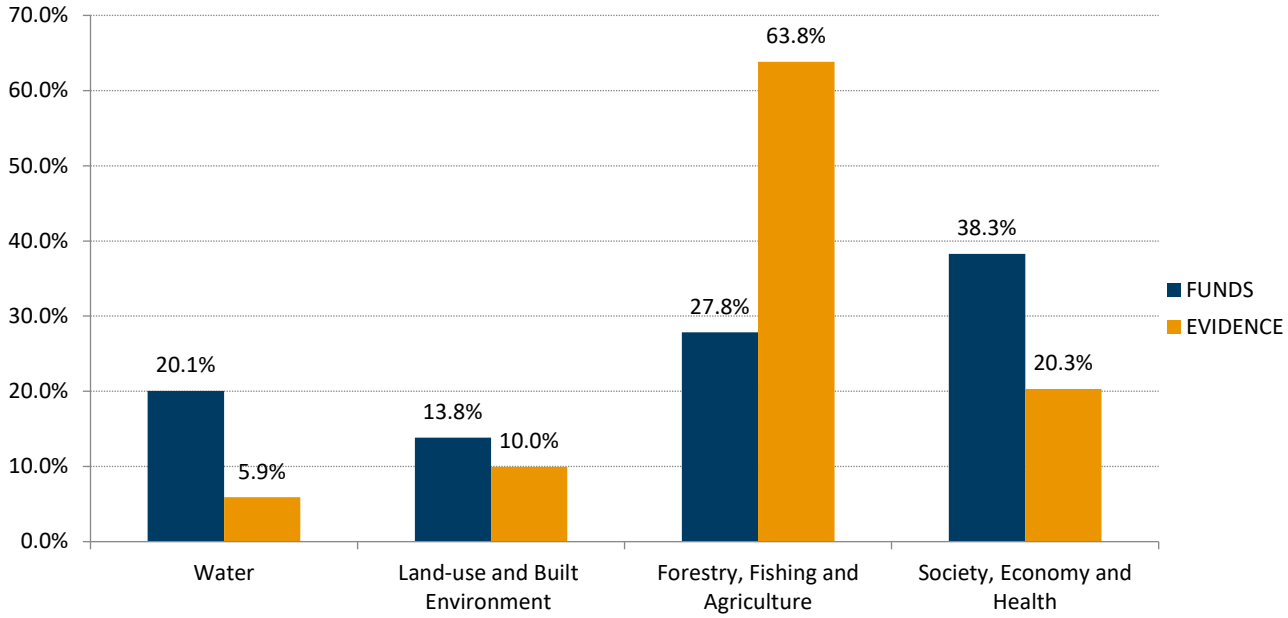
Source: authors` own figure

Distribution of outcomes in the Intervention Heat Map (German Cooperation)



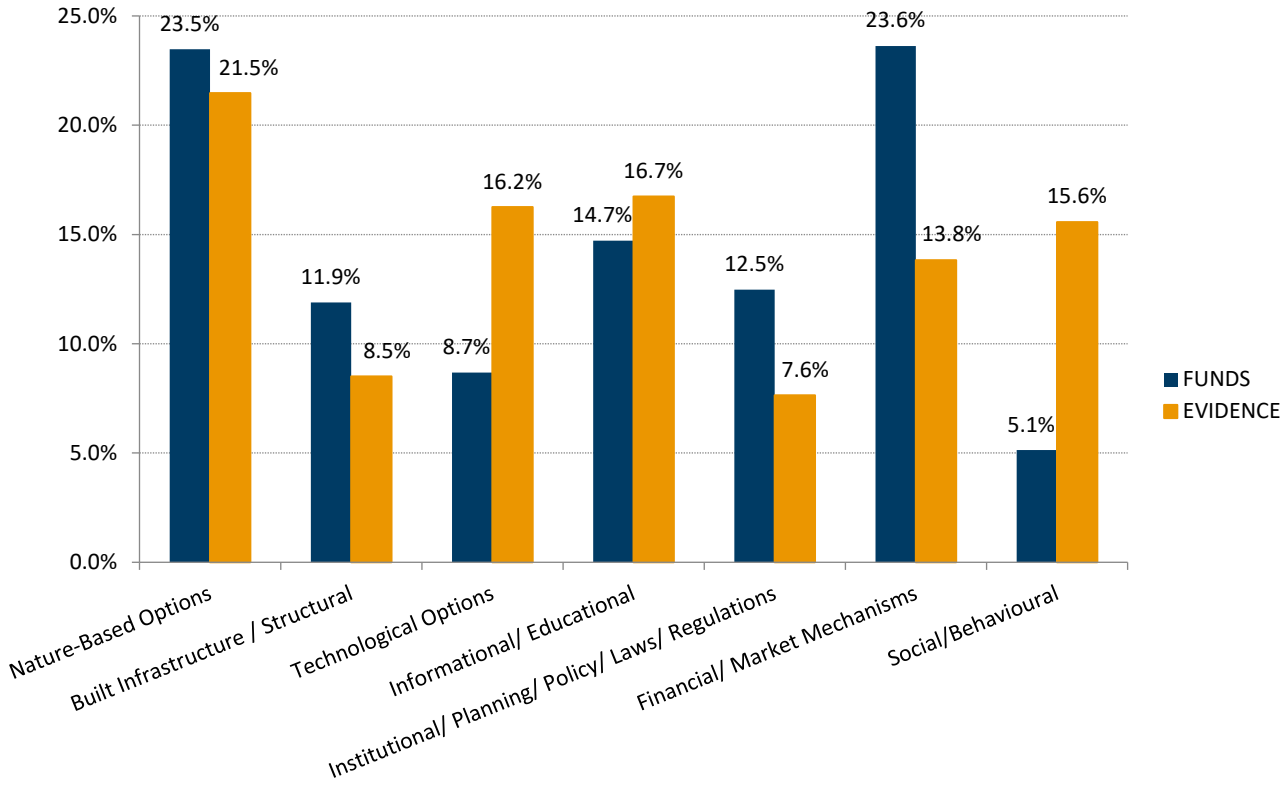
Source: authors` own figure

Distribution of German Cooperation funds and evidence for adaptation in each sector of the EGM



Source: authors` own figure

Percentage distribution of German Cooperation funds for adaptation intervention types compared with the percentage distribution of research evidence



Source: authors` own figure

Annex 5. Intervention Heat Maps for the GCF

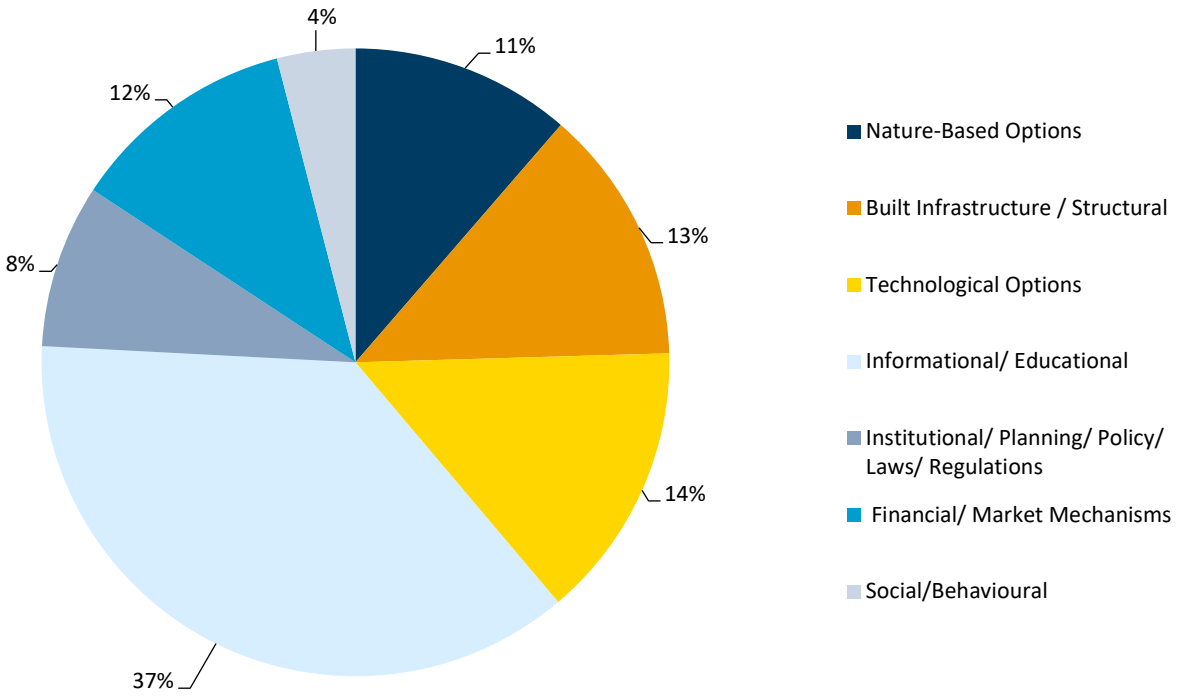
IHM of GCF (number of project/investment interventions) overlaid with the EGM (left: IHM in blue, right: EGM in orange)

INTERVENTION HEAT MAP (number of investment interventions) overlayed with EVIDENCE GAP MAP		UPTAKE		SHOCKS AND STRESSOR				ADAPTIVE CAPACITY				ENABLING ENVIRONMENT					
SECTORS	INTERVENTION/OUTCOMES	Adoption		Decreased exposure		Decreased Impacts/Risks		Social benefits		Economic benefits		Environmental systems		Socioeconomic systems		Institutional systems	
	Example specific outcomes indicators	Uptake		Population affected by extreme weather events		Proactive and reactive risk management; climate related illness; deaths; food security		Skills acquired, access, awareness		Livelihood diversification, productivitiy gains, access		Area protected, ecological services improved		Social capital enhanced, overall poverty measurements		Policy changes, regulations approved, institutional reform	
Water	Nature-Based Options			3					1		3	1	3				
	Built Infrastructure / Structural		1	7	1	6	10	3	2	2	9		3	2	2		
	Technological Options			2		2	1				1	1	1	1			
	Informational/ Educational	2	2	1		2	3			1	1		1	3		9	
	Institutional/ Planning/ Policy/ Laws/ Regulations	1	1			1	3		1		2	2				2	
	Financial/ Market Mechanisms	1	1				1						2				
	Social/Behavioural		1				1	1	1		1		1	1			
Land-use and Built Environment	Nature-Based Options		1	4	14	1	4		1		3	9	2		1		
	Built Infrastructure / Structural		3	2	4	3	4			2	5	2	3		1		
	Technological Options						1			1		1	3			1	
	Informational/ Educational	3	3				4		1				3	2		6	
	Institutional/ Planning/ Policy/ Laws/ Regulations	2	2		3	1	2		1		4	3	4		2	1	2
	Financial/ Market Mechanisms	1	2				2		1	6			2				
	Social/Behavioural		1		1		5		3		2		2	1	1		
Forestry, Fishing and Agriculture	Nature-Based Options		3	1	2	1	29		2	6	106	4	34	1	8		
	Built Infrastructure / Structural		11			2	5		1	2	9		1				
	Technological Options		7		2	3	19		2	7	100		17	1	5		
	Informational/ Educational	3	77		1	1	7		9	8	19		5	9	5	3	
	Institutional/ Planning/ Policy/ Laws/ Regulations	1	14				3		1	2	5				3	1	
	Financial/ Market Mechanisms	2	44		1	2	6		4	10	14		4		5		
	Social/Behavioural		36				5		3	1	19		4	2	3		
Society, Economy and Health	Nature-Based Options		1				3		1								
	Built Infrastructure / Structural		1			1	9				3			1		1	
	Technological Options			2		6	8			1		1		5	1	4	
	Informational/ Educational	3	9		2	2	10		8	1	2			16	1	26	
	Institutional/ Planning/ Policy/ Laws/ Regulations		2		1	1	15				4			3	2	2	2
	Financial/ Market Mechanisms	7	5		1		26		1	3	14		1		5		1
	Social/Behavioural		13		2		24		5	1	17		1	2	6	2	3

IHM of GCF (budget, millions of USD) overlaid with the EGM (left: IHM in blue, right: EGM in red)

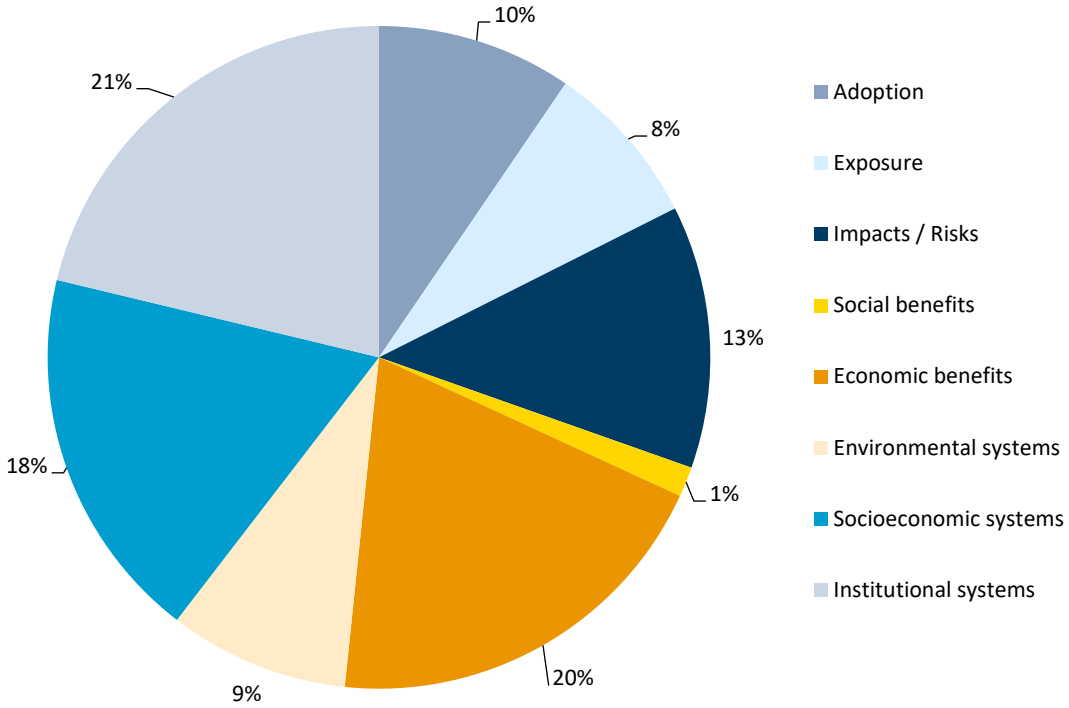
INTERVENTION HEAT MAP (budget, millions of USD) overlayed with EVIDENCE GAP MAP		UPTAKE		SHOCKS AND STRESSOR				ADAPTIVE CAPACITY				ENABLING ENVIRONMENT					
SECTORS	INTERVENTION/OUTCOMES	Adoption		Decreased exposure		Decreased Impacts/Risks		Social benefits		Economic benefits		Environmental systems		Socioeconomic systems		Institutional systems	
	Example specific outcomes indicators	Uptake		Population affected by extreme weather events		Proactive and reactive risk management; climate related illness; deaths; food security		Skills acquired, access, awareness		Livelihood diversification, productivitiy gains, access		Area protected, ecological services improved		Social capital enhanced, overall poverty measurements		Policy changes, regulations approved, institutional reform	
Water	Nature-Based Options			24.69					1		3	11.17	3				
	Built Infrastructure / Structural		1	217.38	1	135.45	10	77.52	2	44.64	9		3	32.79	2		
	Technological Options			5.75		6.74	1				1	1.42	1	7.83			
	Informational/ Educational	2.89	2	7.04		7.95	3			3.29	1		1	9.47		21.67	
	Institutional/ Planning/ Policy/ Laws/ Regulations		1			4.15	3		1		2	0.23				4.54	
	Financial/ Market Mechanisms	9.30	1				1						2				
	Social/Behavioural		1				1	1.73	1		1		1	1.53			
Land-use and Built Environment	Nature-Based Options		1	21.64	14	4.79	4		1		3	115.41	2		1		
	Built Infrastructure / Structural		3	25.62	4	66.36	4			2.67	5	241.96	3		1		
	Technological Options						1			14.99		59.07	3			1.51	
	Informational/ Educational	3.62	3				4		1				3	2.59		20.69	
	Institutional/ Planning/ Policy/ Laws/ Regulations	4.96	2		3	4.99	2		1		4	5.74	4		2	5.06	2
	Financial/ Market Mechanisms	6.30	2				2		1	28.50			2				
	Social/Behavioural		1		1		5		3		2		2	0.65	1		
Forestry, Fishing and Agriculture	Nature-Based Options		3	3.50	2	6.54	29		2	65.91	106	33.39	34	1.58	8		
	Built Infrastructure / Structural		11			26.40	5		1	35.03	9		1				
	Technological Options		7		2	3.12	19		2	49.28	100		17	1.17	5		
	Informational/ Educational	27.31	77		1	2.62	7		9	45.37	19		5	33.43	5	6.16	
	Institutional/ Planning/ Policy/ Laws/ Regulations	6.81	14				3		1	1.00	5				3	0.87	
	Financial/ Market Mechanisms	38.04	44		1	7.54	6		4	77.79	14		4		5		
	Social/Behavioural		36				5		3	7.77	19		4	2.46	3		
Society, Economy and Health	Nature-Based Options		1				3		1								
	Built Infrastructure / Structural		1			28.33	9				3			5.06		2.35	
	Technological Options			9.32		27.79	8			19.39		1.52		17.07	1	19.76	
	Informational/ Educational	8.74	9		2	30.49	10		8	0.61	2			62.71	1	132.64	
	Institutional/ Planning/ Policy/ Laws/ Regulations		2		1	2.45	15				4			16.71	2	1.02	2
	Financial/ Market Mechanisms	231.95	5		1		26		1	12.22	14		1		5		1
	Social/Behavioural		13		2		24		5	5.93	17		1	7.61	6	4.11	3

Distribution by intervention type in the Intervention Heat Map (GCF)



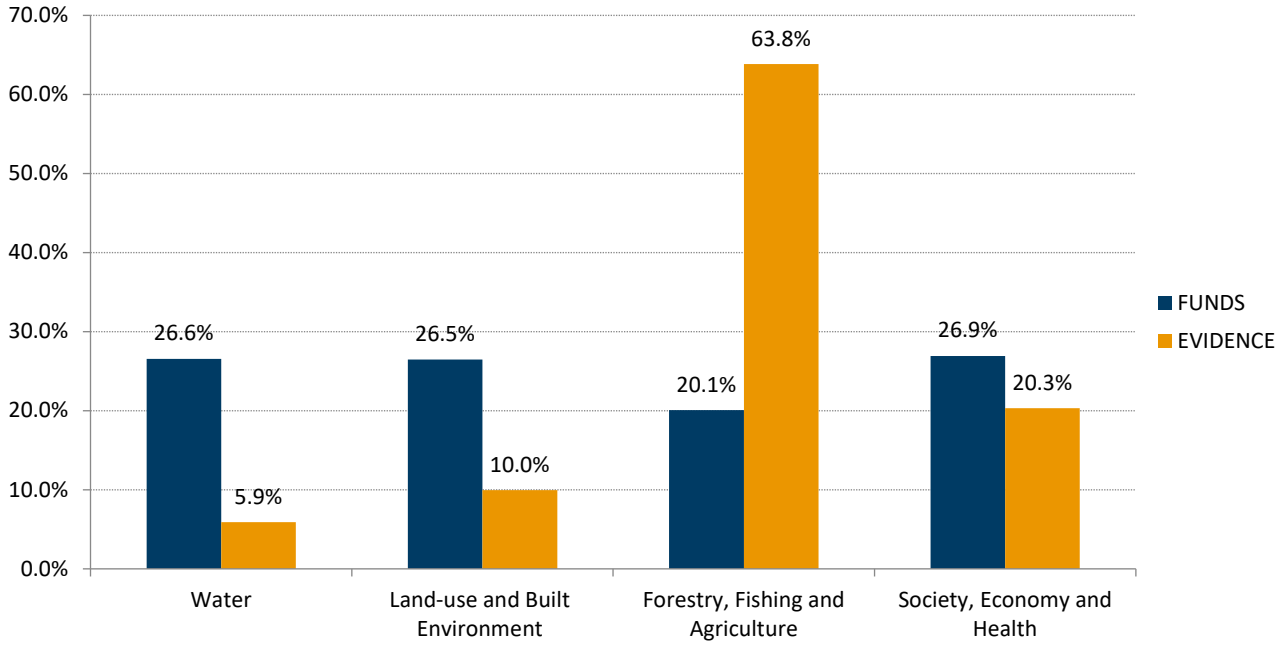
Source: authors` own figure

Distribution of outcomes in the Intervention Heat Map (GCF)



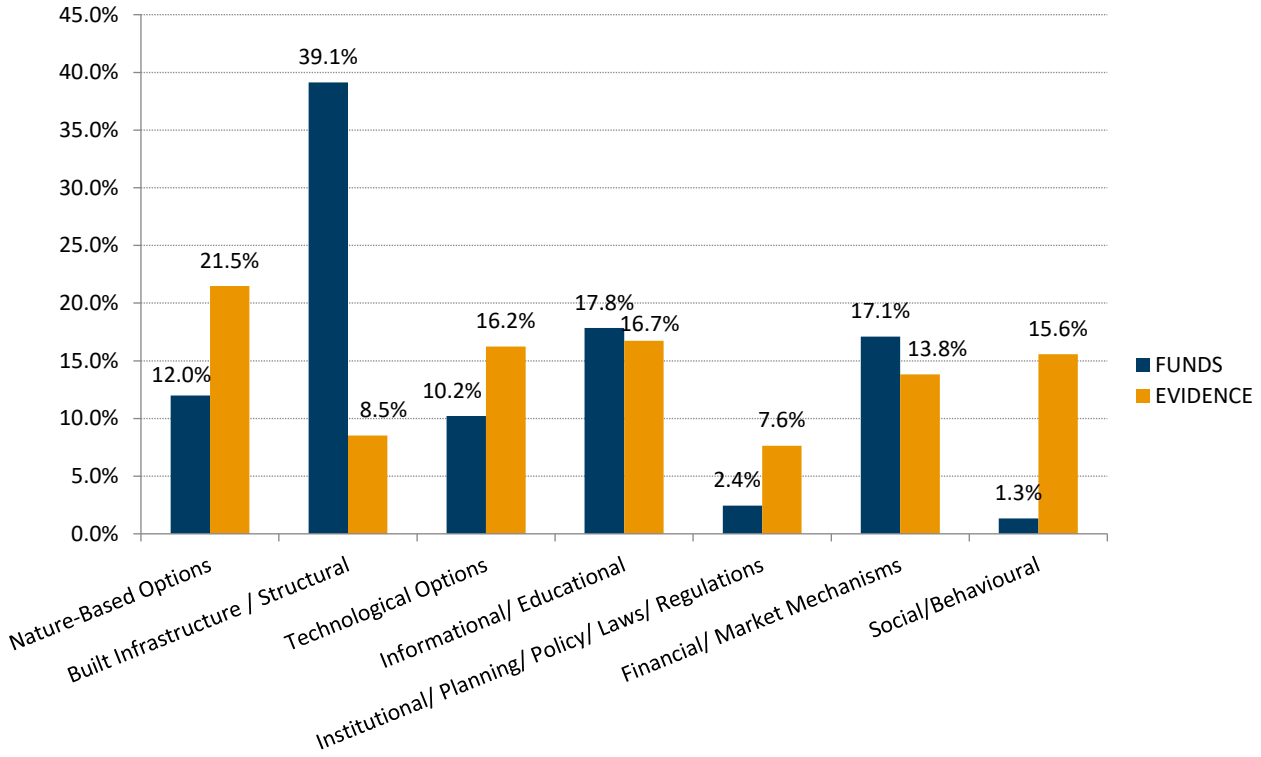
Source: authors` own figure

Distribution of GCF funds and evidence for adaptation in each sector of the EGM



Source: authors` own figure

Percentage distribution of GCF funds for adaptation intervention types compared with the percentage distribution of research evidence



Source: authors` own figure